SEPTEMBER 1959

Power Engineering

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Gas Tempering: **Report No. 2**

Electric Utilities Find Points Way to

B&W Cyclone Furnace Universal Pressure Boiler.
Coal is the primary fuel with oil as an auxiliary fuel.

Gas Tempering Fuel Economies

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Gas Tempering—is the reintroduction of cool flue gases near the furnace outlet to control the temperature of the gases entering the convection surface. It is the practical means to help you burn the most economical, most easily available fuel.

Gas Tempering enables you to burn a variety of coals without slagging.

It minimizes external corrosion of superheater tubes. It reduces metal temperature, cuts need for high alloys, prolongs tube life, regardless of the fuel burned.

In effect, gas tempering allows you to adjust the size of your furnace to meet the characteristics of the fuel. This is done by varying the amount of tempering to chill the furnace exit gases to a temperature known to be satisfactory for the fuel burned. The gases are cooled but the total heat available to the superheater remains the same.

That's Why with Gas Tempering, you no longer need to pass up attractively-priced fuels.

Definitive Booklet: If you'd like to learn more about the economies and design flexibility available to you through Gas Tempering, write for Bulletin G-96. Address: The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

Major Advantages of B&W Gas Tempering

. . . It cuts overall plant costs because the smaller size unit requires a smaller building per kw, a lighter foundation, less structural steel and shorter steam leads.

. . . It enables you to utilize the most economical available fuels. It permits the burning of a variety of coals without slagging, minimizes external corrosion of superheater tubes, and assures safe metal temperature, thus prolonging tube life, regardless of the fuel fired.

. . . It provides safe superheater tube temperature by positive gas temperature control; it protects superheater during startup and under all operating conditions.

. . . It makes it safer to design for economies offered by operation at steam temperatures of 1050 F and above.

B&W

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BOILER DIVISION

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

TURBINE PRICE-CUTS have been announced by General Electric Company for its large steam-turbine-generator units, rated 200,000 kw and larger. Reductions range from $1 per kw on a 200,000-kw unit to $4 per kw on a 600,000-kw unit. Contract price adjustment clause has been modified so as to waive the first 2½ per cent increase in prices resulting from present Bureau of Labor Statistics formulated each year during the life of each sales contract.

Turbine-generator price reductions and the revision in the price adjustment clause are the result of engineering design innovations on these larger-rated turbine-generator units and improvements made in manufacturing techniques. At the same time, General Electric's medium steam turbine, generator and gear department (MSTG&G), Lynn, Mass., and the gas turbine (GT) department, Schenectady, have also adjusted the pricing policy on their products.

Westinghouse and Allis-Chalmers have indicated that they will remain competitive, so an industry price war is not expected.

AD SERIES by Engineers Joint Council has begun and will continue at intervals through 1959. "Scientists make it known, but engineers make it work" is the theme of the campaign. The ads are designed to help news writers and editors present to the public a better picture of the engineer and what he does. They will also help to clear up existing confusion between "scientists" and "engineers", terms frequently used interchangeably.

MEETINGS AHEAD: Fall meetings in regions of the National Assn of Corrosion Engineers have been scheduled as follows: Western at Bakersfield, Cal, Sept 29–30 and Oct 1; Southeast in Jacksonville, Fla, Oct 1–2; Northeast in Baltimore, Oct 5–8; South Central in Denver, Oct 12–15.

For anyone connected in any way with diesel engine operation and maintenance, University of Illinois offers a short course at Allerton Park, Monticello, Ill., September 20–24. R. K. Newton, 116 D Illini Hall, Champaign, Ill., is in charge.

The School of Engineering, Louisiana Polytechnic Institute, Ruston, La, announces the Eighth Annual Instrumentation Conference, to be held on the campus November 5–6, 1959. Papers will be presented on: Fundamentals of Electric and Electronic Instrumentation; Electronic Computers for Automatic Plant Operation; Air Drying of Paper; Electronic Instrumentation in Static Testing of Solid Propellant Rocket Power Plants; Process Stream Analyzers of the Chromatographic Type; Discussion of A.G.A. Report No. 3.

MEDIAN INCOME for professional engineers rose to a record high of $10,000 in 1958, reports the National Society of Professional Engineers. The figure is based on an analysis of 19,240 questionnaires returned by NSPE members for a fourth biennial income and salary survey.

Chemical engineers again reported the highest earnings, with a median income of $11,170. Civil engineers remained on the bottom of the salary rung despite a jump in median income from $8750 to $9620. The gap between earnings in industry, educational institutions, and the federal government was narrower in 1958 than it had ever been before.

COMPLETE AUTOMATIC hot and cold starting, normal and emergency shutdown, and continuous control of the boiler-turbine-generator systems are being provided by an advanced electronic control system made by GE for Huntington Beach Station of the Southern California Edison Co. The station is getting two new cross-compound steam turbine-generator units, boosting its capacity to 820,000 kw.

The Huntington Beach computer control system will continuously scan 900 points, log 50 critical

quantities each hour, and identify and print out information from more than 300 alarm points. Information will be stored in a 16,000-word magnetic drum memory. Corrective action will be initiated automatically by the computer.

WESTINGHOUSE will spend more than $25,000,000 to expand and modernize facilities for the manufacture of turbines, generators, large motors, and related heavy apparatus at plants in Lester, Pa, East Pittsburgh, and Sunnyvale, Calif. The extensive program has been initiated to provide adequate manufacturing facilities to meet anticipated peak loads during the 1962–64 period.

At the heart of the program is a new engineering concept — the development of "pre-engineered" basic components for steam turbines that can be manufactured in any duplicate sets and used as needed for specific customer orders.

In the past, steam turbines have been almost completely custom-engineered for each specific application. Frequently this applied to individual components as well as the over-all turbine arrangement. Now, Westinghouse pre-engineered basic elements can be assembled like building blocks in almost any combination from tandem-compound, double-flow units to cross-compound, octuple-flow units, and for ratings from 100,000 to 800,000 kw.

MEETING to discuss the Government's proposed experiment with nuclear explosives in underground oil-shale deposits of the West is planned by the Bureau of Mines. Invitees will be petroleum and chemical producers. The meeting will be the second to be arranged for industry by the Bureau of Mines and the Atomic Energy Commission as part of the latter's Plowshare Program.

Twenty-one major petroleum and chemical firms have responded thus far to a Government poll of their opinions on the nuclear project, to be followed by an experiment in which the shale broken by the explosion would be retorted to oil in place. All but two indicated that the project should be conducted, and several expressed willingness to participate and help finance at least part of the project.

WALKER LEE CISLER, new president of ASME, was born in Marietta, Ohio. He has spent his entire business career in the electric power industry.

Walker Lee Cisler, President of ASME

Following his graduation from Cornell University in 1922, with the degree of mechanical engineer, Mr. Cisler became associated with the Public Service Electric and Gas Co. He remained with that organization until 1943, advancing to the position of assistant general manager of the Electric Department.

In 1943 he resigned from Public Service Electric and Gas to become chief engineer of power plants for the Detroit Edison Company. He was elected executive vice-president in 1948, a director and president in 1951. As an executive of the Detroit Edison Company, he has been actively engaged in the atomic energy development since shortly after the end of World War II.

Mr. Cisler has been decorated by seven European governments and by the United States government in recognition of his interest in their behalf, both during and since the war.

TVA added 540 miles of high-voltage transmission lines and 12 new substations to its power system during the 1959 fiscal year, at a cost of $25,000,000. The additions brought the system transmission line total to nearly 12,000 miles, and the number of substations to 269. About 360 miles of the new transmission lines are for operation at 161,000 volts and are necessary chiefly to transmit into the system the power produced by new generating units at TVA's steam plants.

Second item of news interest from TVA reveals that the Authority has started to sell fly ash from the Colbert Steam Plant to a newly-formed company, the Dixie Fly Ash Corporation of Tuscumbia, Alabama. The ash is used by producers of concrete products to improve the quality of such products while saving in the amount of cement normally used.

TVA has been working for some time to develop productive uses for this by-product of its power generation, and has used large quantities of fly ash in the construction of its new navigation lock at Wilson Dam and extension of the powerhouses at the Johnsonville and Widows Creek Steam Plants, with substantial cost savings. Its investigations include possible new uses of the material in the manufacture of cement and in highway construction.

ABOUT PEOPLE: Dr. Clarence Zener, director of the Westinghouse research laboratories in Pittsburgh, will receive a John Price Wetherill Medal from the Franklin Institute for his contributions to the field of solid state physics and in particular to the physics of metals, and also for "his unusual ability to stimulate important work on the part of others."

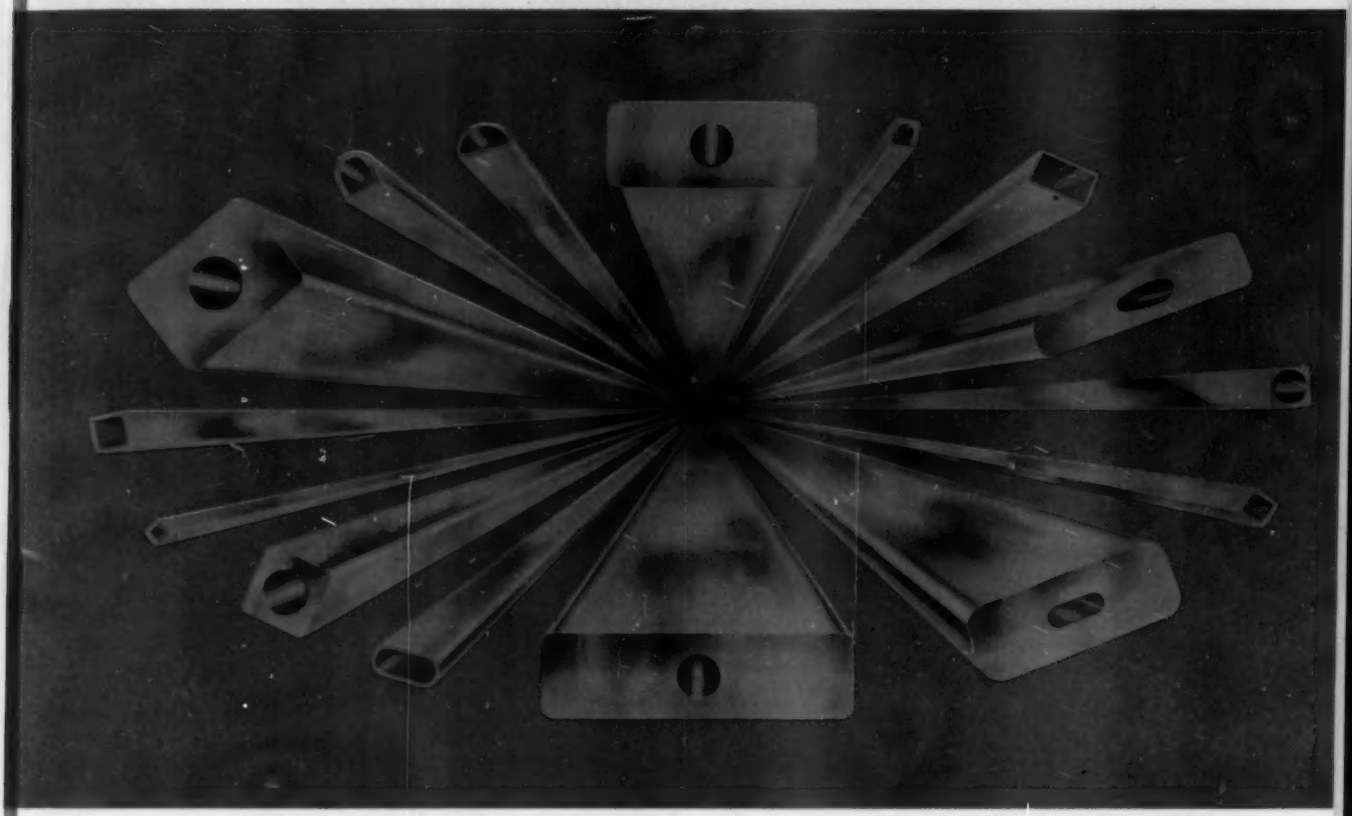
Stevens Institute of Technology has conferred the honorary degree of Doctor of Engineering on Ralph C. Roe, president of Burns and Roe, Inc, consulting engineers.

Paul S. Nurko has been appointed Works Manager of De Laval Steam Turbine Company, Trenton, N. J. Before this promotion, Mr. Nurko was general superintendent of the manufacturing division.

Four top executives of Stone & Webster Engineering Corp have been elected vice presidents. They are Harold C. Cleary and Donald N. McCord, construction managers; M. H. Cutler, engineering manager; and William R. Prang, West Coast district manager.

George A. Stetson, editor emeritus, The American Society of Mechanical Engineers, including *Mechanical Engineering* magazine, died June 20, 1959, in Stamford, Conn. He was 70 years of age. Mr. Stetson was credited with raising *Mechanical Engineering* to a prominent position among technical journals. Educated at Yale University, Mr. Stetson received the PhB degree in 1910 and a graduate degree in mechanical engineering there five years later. He joined ASME in 1928.

THE SHAPE OF THINGS TO COME WITH ANACONDA ELECTRICAL COPPER



Fluid-cooled copper conductors. The growing need for compact electrical assemblies which can handle high current densities is leading to an ever-increasing variety of hollow, fluid-cooled copper conductors. The samples shown about three-quarters full size above give some idea of the range of sizes and shapes produced by The American Brass Company.

Nuclear physics magnets are, perhaps, the most spectacular applications of fluid-cooled conductors. These hollow conductors range from tube .182" square O.D. x .083" square I.D. to heavy rectangular bars with a round core for water cooling.

Industrial applications. The use of fluid-cooled conductors is growing rapidly in large electrical equipment. Generator output can be greatly increased, without increasing frame size, by cooling stator and rotor bars. Fluid-cooled conductors are being used in heat sinks for rectifiers and induction furnace coils. Another interesting use is in compact water-cooled windings needed to provide very high flux densities in, for example, the ceramic magnet manufacturing process. These "solenoids" are being built for applications in which the current range is from a few hundred to about 2000 amperes.

Technical assistance. Whatever your problem —liquid-cooled field coils, rotor bars or a special-shape tubular conductor—technical specialists at The American Brass Company will gladly help you work out the size and shape best adapted to your needs. See your American Brass representative or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 3943A

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WHAT THEY TELL US

▶ **RED FACE DEPARTMENT:** Great injustice was done to two people in the article Water or Steam Injection in Gas Turbine Cycle Provides Unique Performance, June, page 93.

In that article, the curves of Figs. 3, 4 and 5 were adapted and re-drawn from curves taken by J. G. Coutant, the author, from an article in the French technical magazine *Chaleur et Industrie* (Heat and Industry). That article was written by P. Chambadal, Chief of Service of the Thermal Research Section of Electricité de France in Paris. Mr. Coutant translated and adapted portions of Mr. Chambadal's article and we, in turn, abridged and re-wrote it somewhat.

Now all this procedure was noted in a footnote when we prepared the manuscript of Mr. Coutant's article. Unfortunately, in some way known only to the gremlins who haunt editorial offices, that footnote was dropped from the manuscript and its omission was not discovered until after the issue was off the press. A short time later Mr. Chambadal himself noted this, and wrote us:

> I am a reader of POWER ENGINEERING for many years and I am very often interested in the papers you publish on power generation. Thus I appreciated in your June issue J. G. Coutant's paper on water or steam injection in gas turbine cycle. My appreciation was the greater in that I recognized in the graphical analysis and performance curves (Figs. 3, 4 and 5) a reproduction of curves calculated by myself and published two years ago in a French technical journal *Chaleur et Industrie* (July 1957).
>
> Of course, I am delighted to learn that the results of my calculations are now brought to the knowledge of the readers of POWER ENGINEERING. But I think it would be only fair to let your readers know the sources of Mr. Coutant's documentation.

▶ **IS BY-PRODUCT POWER** production an advisable consideration in designing small industrial plants today? Henry D. Fisher of New Haven, Conn, and Andrew A. Cummins of Ann Arbor, Mich, have been debating this subject in these columns. Both are consulting engineers with long experience. Last month, Fisher urged caution in promoting waste heat and by-product power projects. Now Cummins replies:

In general, we would say that when an installation can be made on borrowed money and can be completely owned after five to ten years, taking into consideration depreciation, interest, insurance, property tax, and Federal income tax, then it should be made.

If done, the owner will, at the end of the payout period, have a plant with a remaining life of 20 years or more from which high earnings are most likely to be assured. New properly designed installations can save labor due to better arrangements, coal due to better boiler efficiency, maintenance due to better equipment, and can produce electric power at a very low fuel cost due to use of the exhaust or extracted steam for processing.

An industrial power plant where the exhaust steam is all used will provide a kilowatt hour for half the number of Btu that the most efficient condensing utility station in the country is able to accomplish.

Also, many times the high pressure installation makes possible improved steam conditions for processing, which means more production and correspondingly increased profits.

If the installation is not made, the owner accumulates a bunch of receipted bills instead of additions to his plant in the form of real property.

While we might with good reason, we think, question a good bit of Mr. Fisher's statements and reasoning, we will raise here just one point. He mentions 530 kwh and 13,000 lb of steam per ton of paper board. The records we have indicate closely the same. The possible power that can be generated, as outlined in his comments, is tied into 400 psig at 650 FTT, and we wonder why.

The 13,000 lb of steam with a 4000-kw turbine using 600 psig and 750-F steam and exhausting at 50 psig and operating at 3500-kw load would generate 614 kw or 15 per cent more than required, and with 700-psig steam at 825 F, steam with 50-psi back pressure will generate 672 kw or 27 per cent more than required.

These higher pressures have been found to be entirely practical in comparatively small paper mills and specially trained men have not had to be employed.

One other point of interest is a recent report by the First National Bank of Chicago. Since the end of World War II, the bank *Review* reports, depreciation or the recovery of the cost of the plant and equipment by deduction from income has come to be the most important single source of funds to corporations.

Summing up, it may be worth management's while to look into accounting methods to see if it is gaining all of the possible benefits of the 1954 law. Perhaps the dollars needed for modern improvement are more feasible and readily available than had been anticipated.

▶ **WEST GERMAN** pumped storage hydroelectric installation, described in the May issue, page 80, used novel methods to seal the storage basin. Rudolf Meister, who contributed the original information, now writes from Hamburg:

> It will be of interest to you to learn that we have emptied the upper basin, which was constructed with a new kind of asphalt concrete sealing, with the purpose of forming a correct idea of the state of the sealing. This made an excellent impression, and neither damages nor deterioration or weak points have been traced.

▶ **OUR SERIES** of eight articles on valve types has proved to be widely useful as a manual, in reprint form. One of the authors of the original articles, Theodore H. Pyle of Lunkenheimer, wrote us the other day:

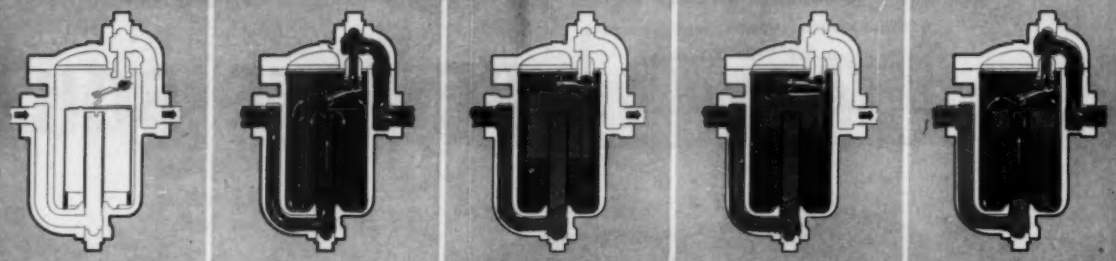
> And now I want to add a word that I have had on my mind ever since the Valve Manual was sent me. Needless to say, I read every word of it. I learned a lot and had a lot of information about valves confirmed. My only comment is that it was written by experts and every detail that should be in a manual is included. You are to be congratulated on conceiving such a publication and carrying it through to completion.

▶ **IS ANYBODY** manufacturing the tilting-type steam trap today? Reader W. F. Dralle has written us as follows:

> We are interested in locating a manufacturer of tilting-type steam traps. As these are practically an obsolete type of trap, let me explain that, in this design, condensate drains through a hollow shaft into a receiver, which when filled, tilts. This shuts off the flow of condensate through the shaft, and opens other passages through the shaft to the condensate return system and the source of high-pressure steam or air, for blowing the condensate back to the boiler.

Years ago in the early 20's, the editorial pages of *Power Plant Engineering* could have provided full information about the tilting trap, for it was manufactured by several companies and used in quite a few boiler plants. However, we cannot find any manufacturer who is making it now. If readers know, will they help Mr. Dralle?

This simple trap operating principle provides the efficiency, dependability and freedom from maintenance necessary for the most profitable use of steam



When trap is first installed, the inverted bucket is down and the valve is wide open.

When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until —

Steam (light color) reaching the trap floats the inverted bucket and closes the valve.

When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.

When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

Key: condensate steam steam bubbles air bubbles

ARMSTRONG INVERTED BUCKET STEAM TRAPS

are designed and made to give you these big benefits:

● Amstrong Traps, the first inverted bucket steam traps, now represent the most advanced development of this time-proven principle. They provide all the advantages necessary for efficient, economical condensate drainage from virtually all types of steam using equipment.

1. *No steam loss* – Steam never reaches the orifice even when there is no condensate load.
2. *Automatic air elimination* – Vent in trap bucket passes air and other non-condensibles through to be discharged with condensate.
3. *No cooling leg required* – Condensate is discharged at steam temperature as fast as it reaches the trap because trap operates on difference in density between steam and water not on temperature.
4. *Operates on any back pressure* – Failure of one trap in system will not cause others to open because high back pressure does not affect an Armstrong trap other than to reduce capacity. As long as there is a pressure differential across the orifice the trap will close on steam and open for condensate.
5. *Unaffected by ordinary dirt* — Swirling action of condensate keeps dirt in suspension until discharged with condensate, prevents it from lodging in valve.
6. *Completely dependable* — Proved design plus the use of all stainless steel working parts assure continuity of service and length of service unmatched by any other trap.
7. *Big capacity in a small, economical package* — Armstrong design gives you the highest practical capacity for any given pressure. And remember, Armstrong capacity ratings are based on *hot* condensate at the *working pressure differential* stated, not on theoretical orifice capacities.

Further information on these advantages plus much additional information is given in the 48 page Armstrong Steam Trap Book. Ask your local Armstrong Representative or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

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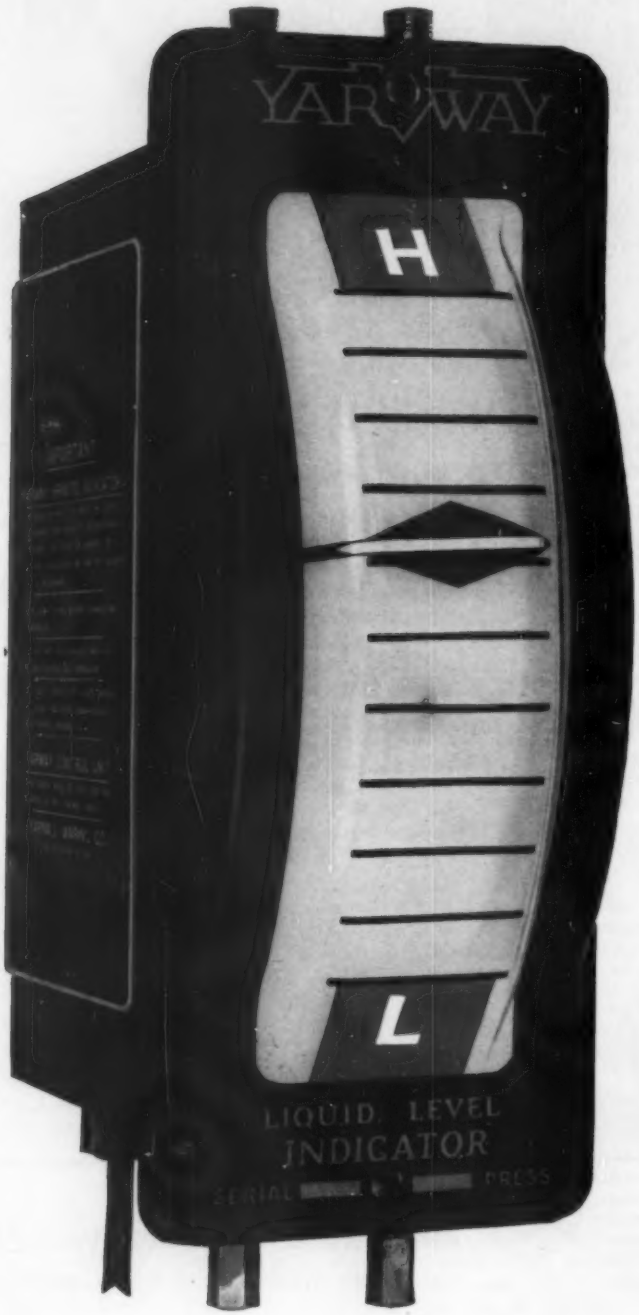
now fully

YARWAY REMOTE BOILER



With the addition of the new pressure compensator described on opposite page, full-scale accuracy of water level indication is provided not only at "working pressure" but *also at all other boiler pressures*

The Yarway Remote Indicator now offers *completely accurate readings of the boiler water level under every operating condition.*

For complete information on Yarway Indicators and pressure-temperature compensation, write for Bulletin WG-1814 and new compensator supplement.

YARNALL-WARING COMPANY
Home Office:
116 Mermaid Avenue, Philadelphia 18, Pa.
Southern Representative:
ROGER A. MARTIN, Bona Allen Building, Atlanta 3, Ga.

NOTE: Ask about the application of Yarway Indicators for 900 psi and higher pressures under Boiler Code Case 1155 (two indicators in place of one of the two required gage glasses).

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...a good way

compensated *

WATER LEVEL INDICATORS

ADVANTAGES OF YARWAY PRESSURE COMPENSATOR

1. Compensating mechanism is applied to the Yarway indicator without change in internal construction of the indicator.

2. Well-known dependability of bourdon tube insures reliability and long life.

3. Trouble-free operation because linkage is simple and direct.

4. For maximum sensitivity, the indicator pointer is mounted on jewel bearings.

5. Rugged shock-resistant mounting carries weight of compensator mechanism without burdening the pointer mechanism.

6. Boiler conditions are readily simulated for check of instrument calibration at operating pressures, with remainder of indicator system under atmospheric pressure.

7. Application of pressure-temperature compensation for density changes in boiler water insures desired accuracy of level indication at all operating pressures and at all points on the pointer scale.

**Pressure compensator available on request, at extra cost.*

Model showing mechanism of Yarway Pressure Compensator. Placed between indicator operating and indicating elements, the compensator mechanism corrects the level indication by changing pointer travel to compensate for variation in water density due to changes in boiler pressure.

(Not shown) Yarway Remote HI-Lo Alarm Signals (lights and/or horns), operated by the Indicator. May be placed at any location in the plant.

(Not shown) Yarway Electronic Secondary Indicator to provide duplicate reading at any other location. Same size and appearance as primary indicator.

to specify remote liquid level indicators

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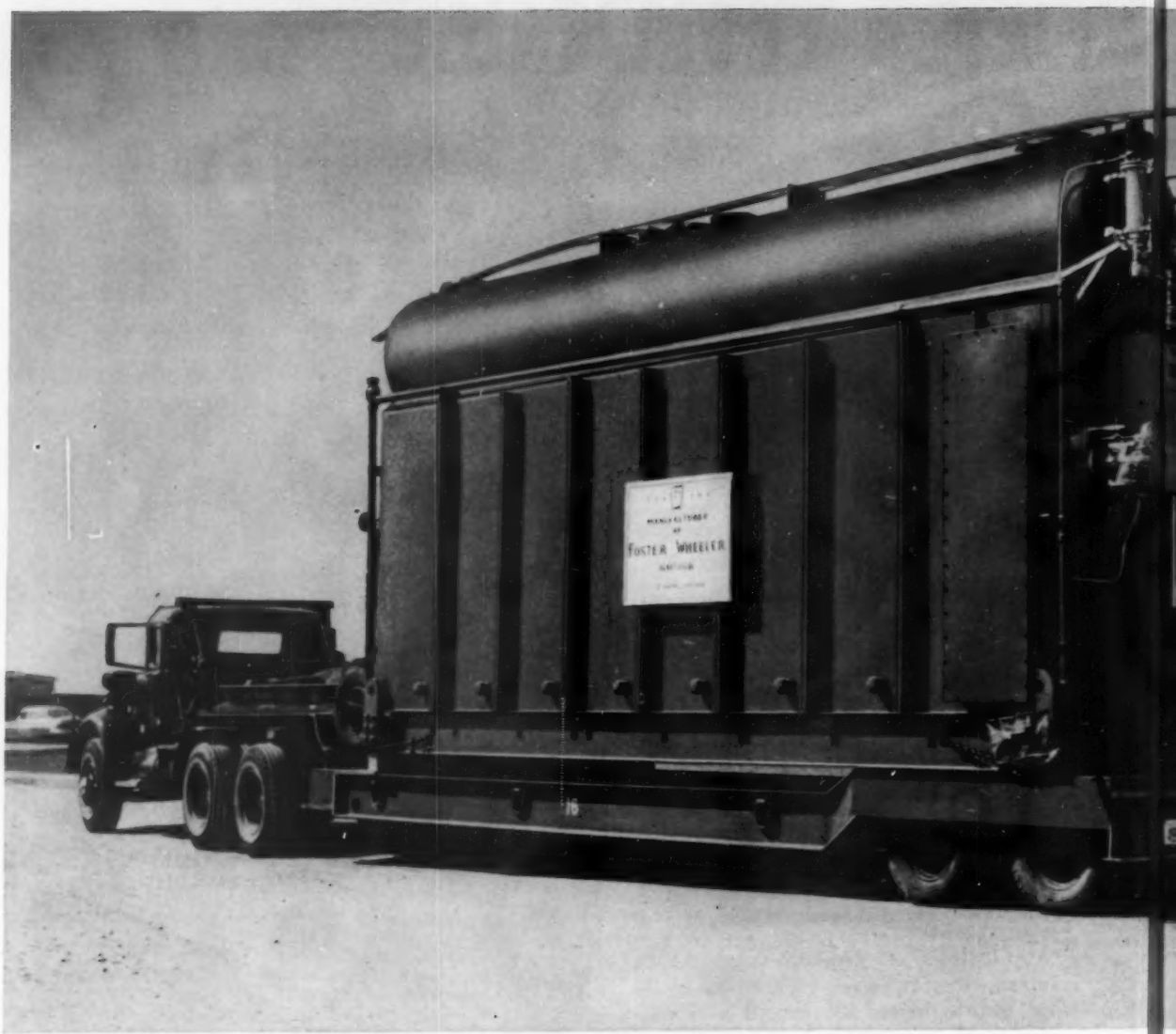

Foster Wheeler Packaged Steam Generator on its way to a refinery, where it is now producing 50,000 lb/hr of high-purity steam for processing and heating purposes.

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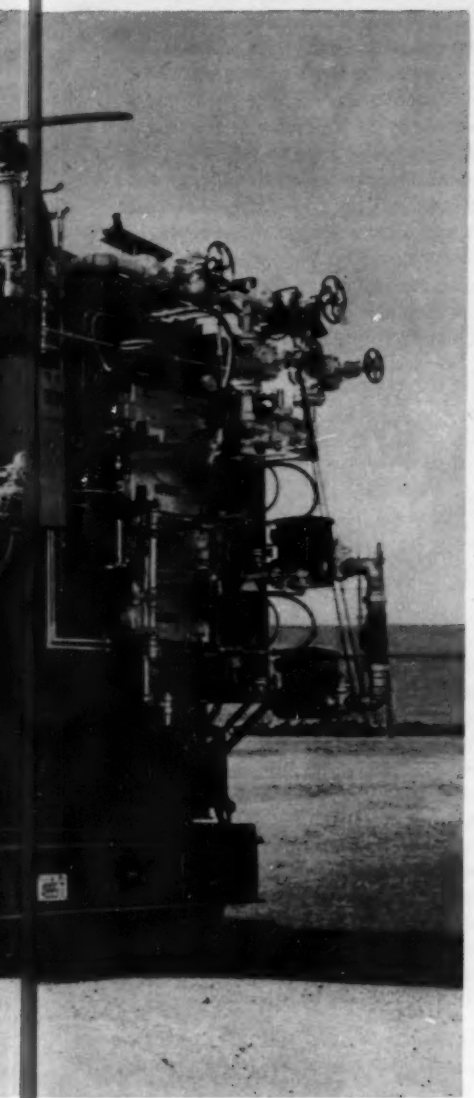
—CHEMICAL PROCESSING



Foster Wheeler delivers the steam you need and the economy and efficiency you want, in one package

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HELPFUL WATER CONDITIONING DATA FROM BETZ

RETURN LINE CORROSION

Causes of corrosion can be readily identified and economically corrected.

Corrosion in the condensate return lines of boiler systems is a frequent problem. To properly prescribe a solution to the difficulty, it is necessary to determine the primary cause of the attack. Prompt elimination of serious return line corrosion is certainly most advisable since necessary maintenance and replacement of pipe and fittings can be quite costly.

By far the most common causes for return line corrosion are the presence of either oxygen or carbon dioxide, or both of these gases dissolved in the condensate. The appearance of the corroded

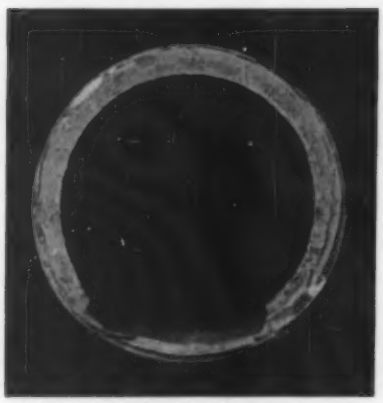

Figure 1—Grooving attack by CO_2 is shown in this end view of the condensate pipe.

sections will be a good indication of the cause. An attack by carbon dioxide will be characterized by an actual thinning of the metal wall of the pipe, with associated grooving of the metal. Such attack is illustrated in Figure 1.

Corrosion by dissolved oxygen will be evident by a series of pits, usually accompanied by deposits of the reddish colored iron oxides. Such attack may be observed in Figure 2. It is not uncommon to see the results of attack which is due to both oxygen and carbon dioxide. The appearance of such sections will have the combined characteristics of oxygen pitting and carbon dioxide corrosion grooving.

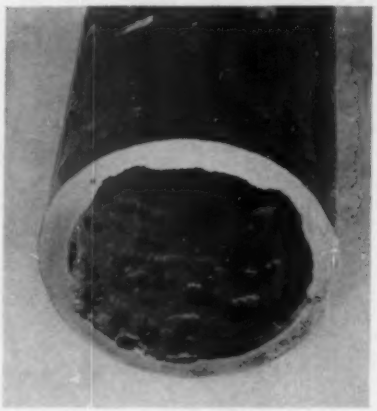

Figure 2—Oxygen pitting attack, distinctly different from CO_2.

Oxygen Attack

Oxygen in steam and condensate may originate directly from the boiler feedwater or may enter at various points in the condensate system. Boiler water makeup will contain appreciable quantities of dissolved oxygen, especially if taken from a surface supply. Since the solubility of dissolved oxygen decreases with increasing temperature, when the feedwater undergoes an increase in temperature in the boiler itself, the dissolved oxygen will be liberated and passed over with the steam. This fact makes the use of an open or deaerating heater of utmost importance in good engineering design of a boiler plant. With such an installation, the major portion of the oxygen in the water will be removed before the water enters the boiler.

The use of an open or deaerating heater removes the oxygen by mechanical deaeration of the boiler feedwater. Since mechanical deaeration is not successful in removing 100% of the dissolved oxygen present, the feed of a chemical deaerant is economically justified to assure that the last traces of the dissolved oxygen are removed. Ordinarily, sodium sulfite (Na_2SO_3) is used for this purpose.

Recently, hydrazine (N_2H_4) has been applied to achieve oxygen removal. The use of hydrazine is usually confined to high pressure installations where the concentration of dissolved solids is critical. Unlike sodium sulfite, hydrazine does not increase the solids of the boiler water.

Oxygen attack can take place not only due to inefficient deaeration of the feedwater, but also through the possibility of oxygen leakage into the condensate. Air infiltration can be expected at condensate pumps, or other points in the system where air may come in contact with the condensate. This potential difficulty can be checked by conducting dissolved oxygen tests on the condensate itself. If it is determined that oxygen is present in the condensate, appropriate mechanical steps can be taken to eliminate or minimize oxygen infiltration.

Carbon Dioxide Attack

Carbon dioxide is the most prevalent cause of return line corrosion, and its source is primarily the feedwater. An open or deaerating heater will remove any free carbon dioxide from the feedwater, but such removal will not eliminate the presence of carbon dioxide in the steam. Since bicarbonates and carbonates present in boiler feedwater will undergo decomposition at elevated temperatures to form carbon dioxide, the result of this decomposition is the chief source of carbon dioxide in the steam. The reactions are as follows:

(1) $2NaHCO_3 + \text{heat} \rightarrow Na_2CO_3 + CO_2 + H_2O$

bicarbonate + heat → carbonate + carbon dioxide + water

(2) $Na_2CO_3 + H_2O + \text{heat} \rightarrow 2NaOH + CO_2$

carbonate + water + heat → hydroxide + carbon dioxide

While reaction (1) will proceed to 100% completion, the decomposition indicated in reaction (2) proceeds to only about 80% completion. All other things being equal, the higher the carbon dioxide content of the steam, the greater will be the corrosion potential. The severity of the anticipated attack may be roughly estimated by conducting

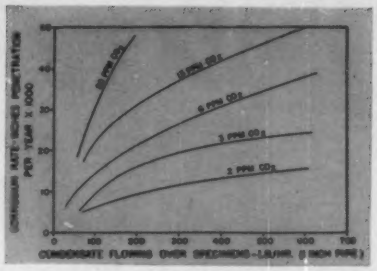

Figure 3—Corrosion rate of CO_2 depends on its concentration and flow rate. Note the drastic rate increase at concentrations above 6 ppm CO_2.

the phenolphthalein and methyl orange alkalinity determinations on the boiler feedwater. In some cases a carbon dioxide concentration as low as 6 ppm may cause a troublesome corrosion problem in the return piping.

However, in addition to the carbon dioxide concentration of the steam, there is one other important consideration in anticipating the severity of corrosion due to carbon dioxide. That consideration is the total pounds of carbon dioxide. Figure 3 clearly illustrates this point. It should be noted that with a carbon dioxide concentration of 6 ppm or above, the rate of corrosion increases rapidly as the rate of flow increases. Another factor which can materially influence the severity of carbon dioxide attack is the possibility of stratification. This leads to a higher rate of attack than expected for the particular flow rate and concentration of carbon dioxide.

Since the carbon dioxide contamination results from an actual breakdown of the carbonate and bicarbonate alkalinity of the feedwater, deaerating practices will be ineffective in reducing the corrosion potential due to this gas. Effective reduction of the corrosion potential may be achieved by external treatment of the feedwater or makeup water to reduce the bicarbonate alkalinity thereof. Such external treating facilities include lime-soda, and lime-gypsum softening, which ordinarily reduce the alkalinity to the 50-60 ppm range. It is advisable, from the standpoint of reducing carbon dioxide corrosion to maintain the softener effluent alkalinity in the carbon-hydrate form, rather than in the form of bicarbonate-carbonate. Other external methods that can be employed to reduce bicarbonate alkalinity to a very low level include acid feed, hydrogen zeolite softening, and dealkalization.

Neutralizing and Filming Amines

When external softening cannot produce a sufficiently low carbon dioxide concentration of the steam, or when the expense for such external treating facilities is not justified, excellent protection from attack can be achieved with the use of neutralizing amines or filming amines.

Neutralization of carbon dioxide can be safely accomplished by certain volatile amines. These amines, when fed to a boiler, volatilize with the steam and combine with the carbon dioxide to neutralize its acidity. Since they react directly with carbon dioxide, the quantity required is proportional to the carbon dioxide content of the steam. Where large amounts of carbon dioxide are present, costs can become excessive.

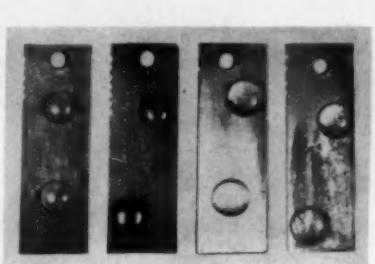

Figure 4—Non-wettability of amine film.

The filming amines function by laying a non-wettable film of monomolecular thickness over the metal surfaces, which is impervious to water. Since the film prevents the water from reaching the metal surface, attack is prevented. The quantity required is independent of the carbon dioxide concentration, and therefore is a more economical treatment particularly where high concentrations of this gas are present. The film forming amines are also effective when oxygen is present in moderate amounts. Figure 4 illustrates the water repellency of the amine film.

Summary

1. Oxygen and carbon dioxide are the chief causes of return line corrosion.
2. Attack by dissolved oxygen is characterized by pits and build-up of deposits of iron oxides.
3. Attack by carbon dioxide is characterized by grooving and actual thinning of the metal pipe walls.
4. Combined attack by oxygen and carbon dioxide will have the characteristics of each.
5. Oxygen attack can be stifled by efficient chemical and mechanical deaeration.
6. Carbon dioxide attack can be inhibited by external reduction of alkalinity and/or use of filming or neutralizing amines.

NEED NOT BE A PROBLEM

A number of factors must be considered on an *individual plant basis* to determine the best way to overcome a return line corrosion problem. Continuing research and development by BETZ LABORATORIES on this important subject has led to a better understanding of the effect of different variables, as well as provided increasingly effective control methods. A BETZ Field Engineer will be happy to discuss your return line corrosion problem and suggest result-producing ways to overcome it. Why not take steps to call him in *now* while you're thinking about it?

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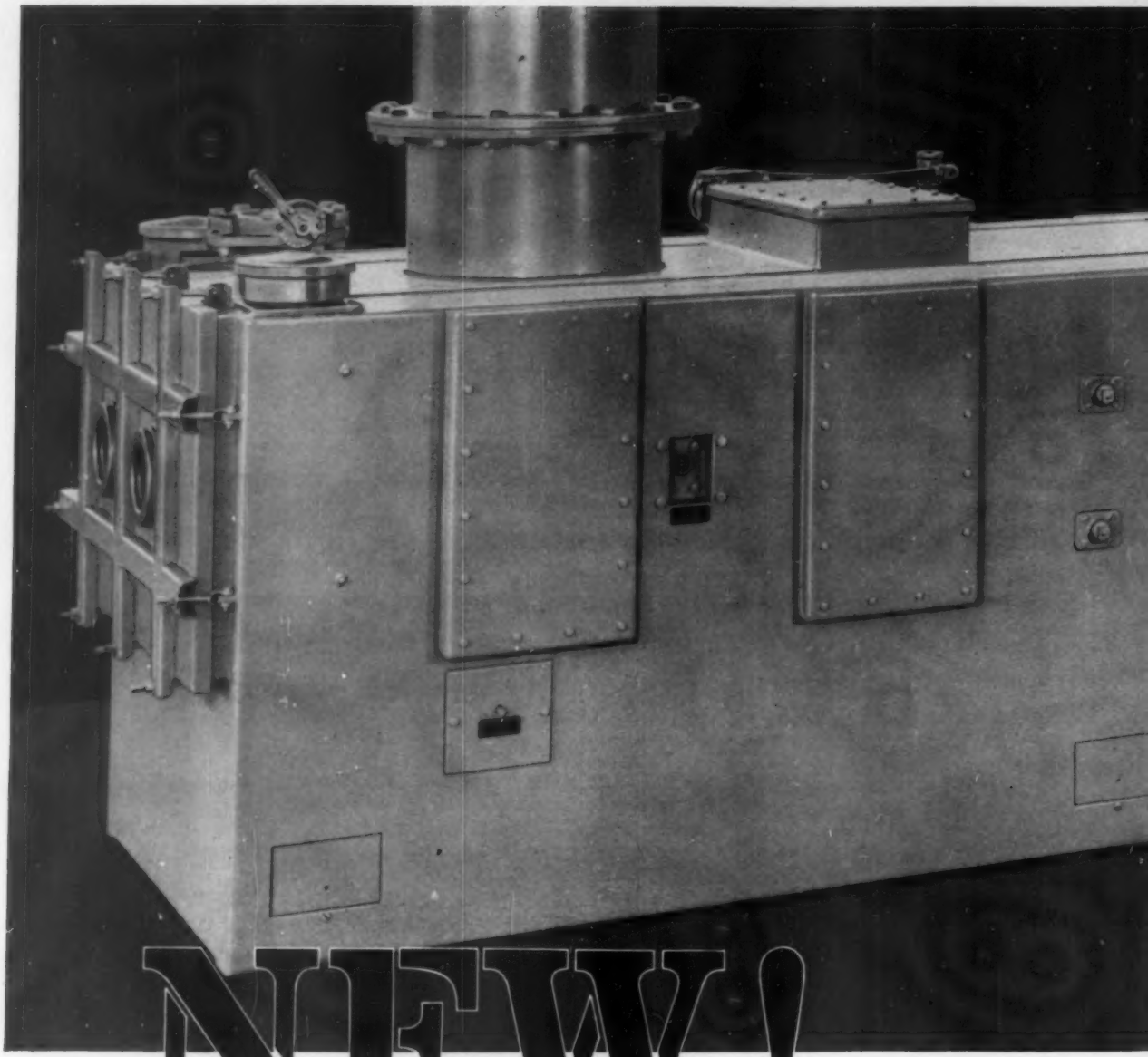

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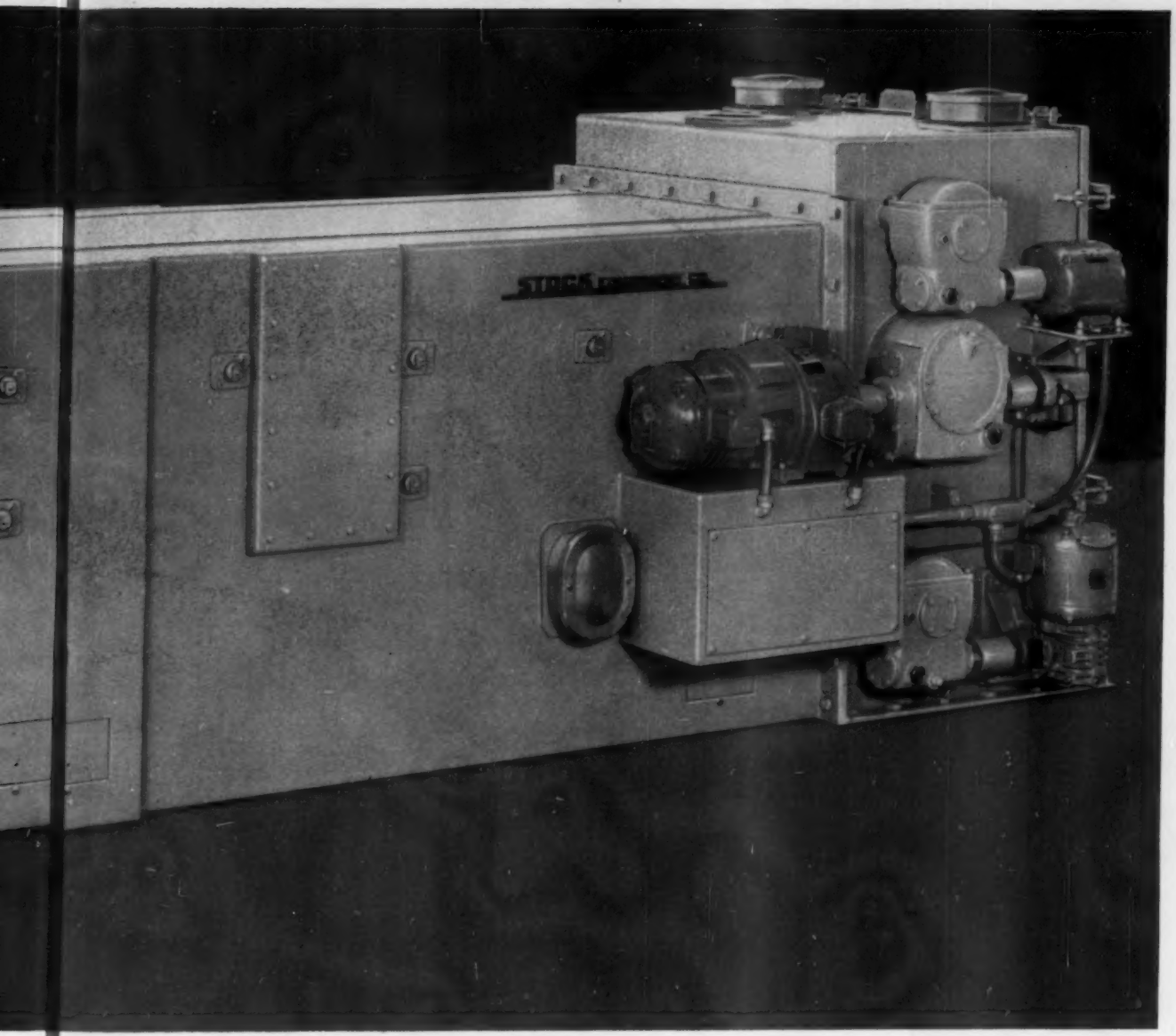

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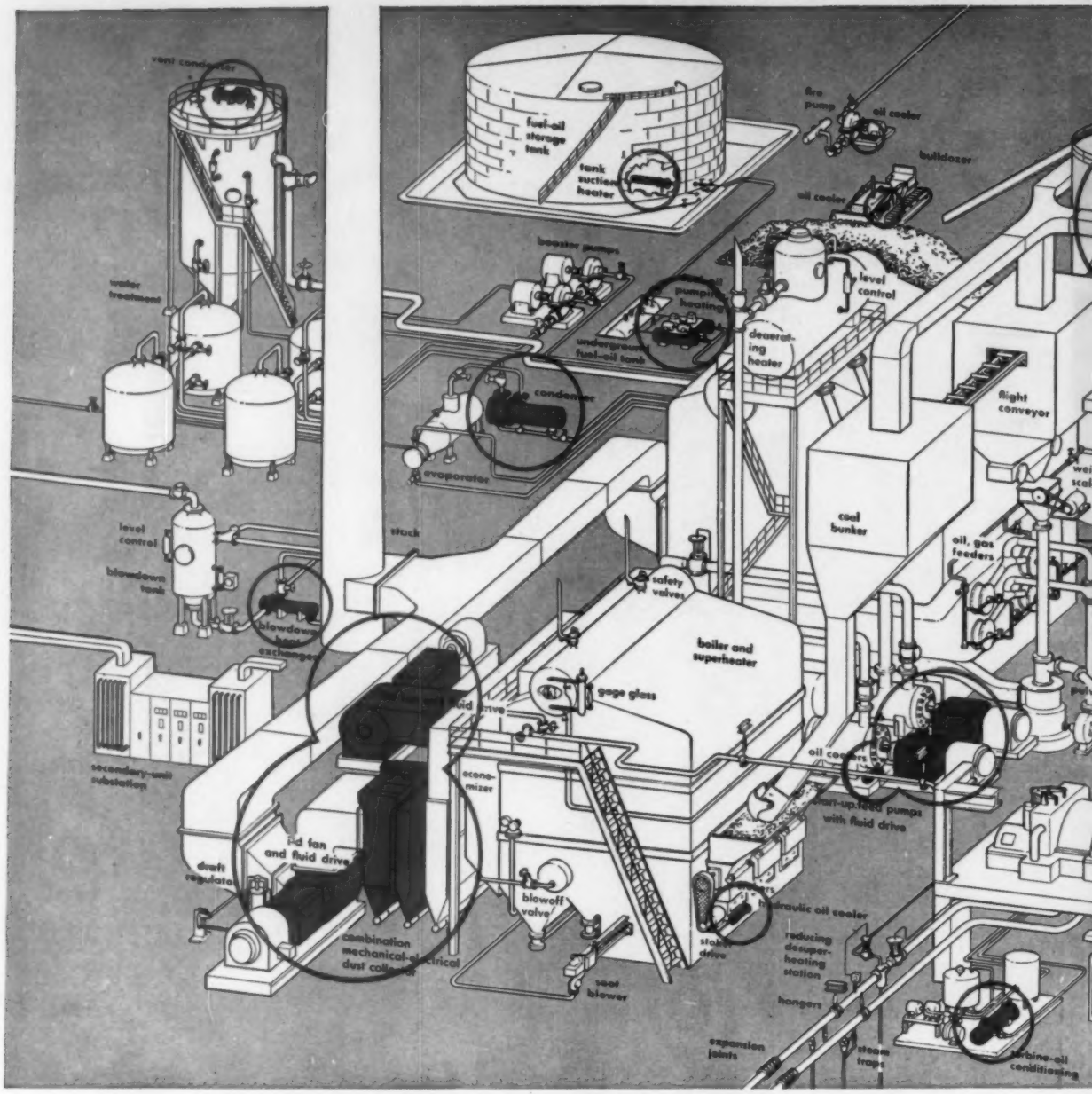

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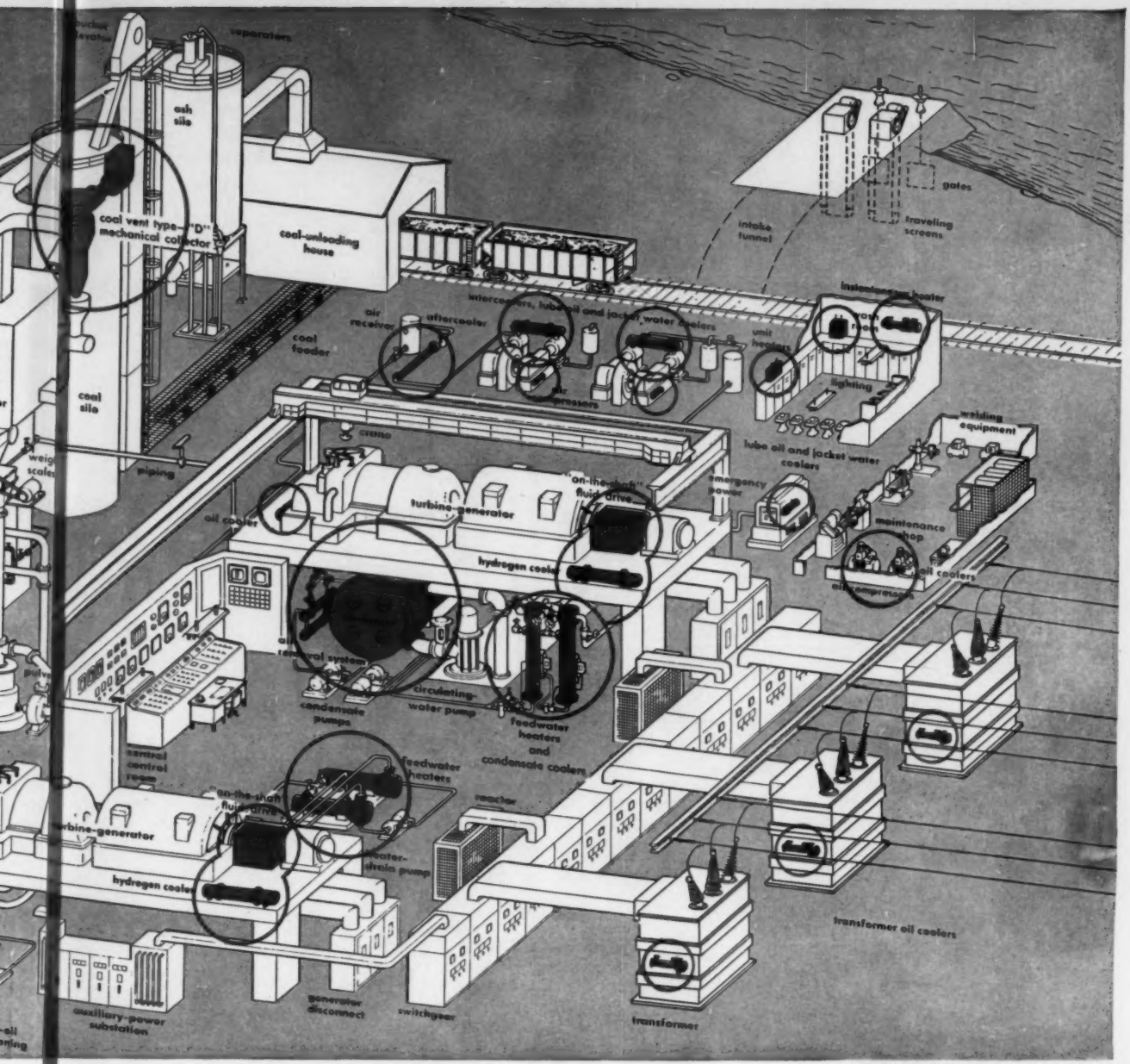

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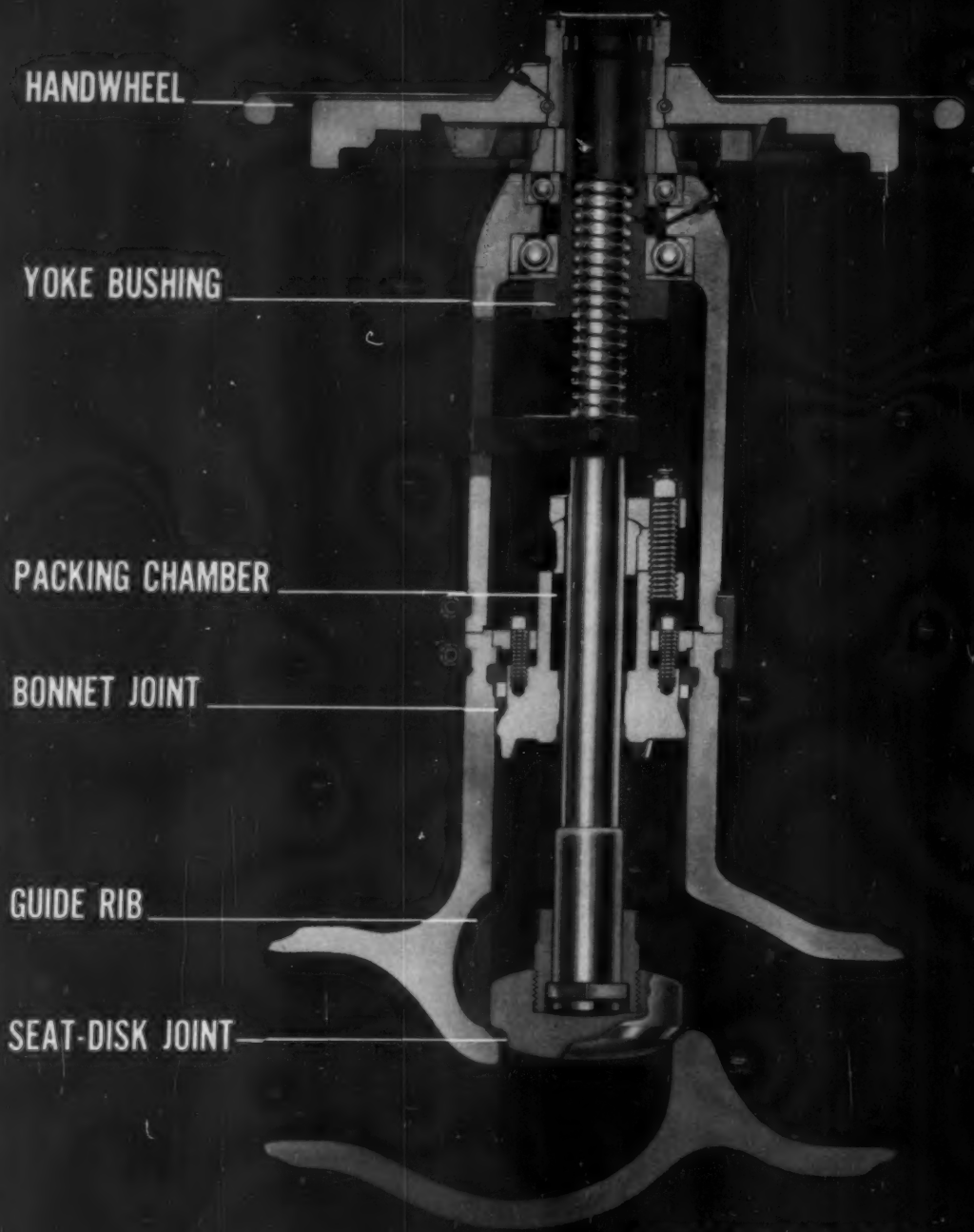
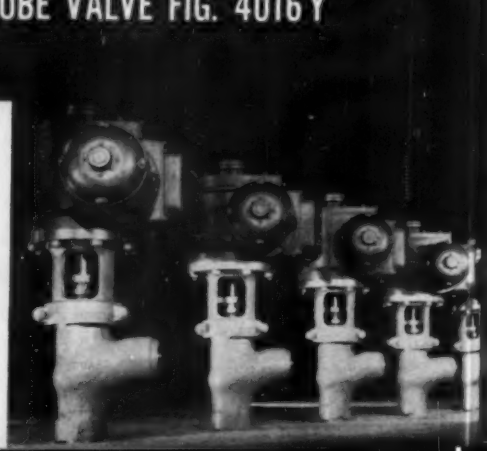


EDWARD CAST STEEL
GLOBE VALVE FIG. 4016Y

IMPACTOGEAR® OPERATED VALVE

MOTOR OPERATED VALVES



What's New from Edward Valves

New Products . . . Solutions to Problems . . . Information on Steel Valves from Edward, Long-Time Pioneer in the Field!

HOW TO SELECT CAST STEEL VALVES

Valves for today's high-pressure processes require economy, dependability and safety in operation. The material on these pages is designed to help acquaint you with a few basic principles and features you should consider when selecting cast steel valves 2½ inches and larger.

VALVE FEATURES FOR LONGER LIFE, EASIER OPERATION

Valve Handwheel should be large enough to operate valve easily. On smaller valve sizes, a knobbed handwheel design permits tighter grip. But for larger, high-pressure valves, impact-type handwheels will increase closing force, insure tighter closure (see large illustration opposite page). Quick closing can be obtained with impact-type handwheels geared for closing with the aid of portable air or electric wrenches (bottom-left, opposite page). Or, where central or automatic control is desired, consider fixed motor operation (bottom-right, opposite page).

Yoke Bushing on larger valves in higher pressure classes should be equipped with double ball-bearing construction for reduced operating torque and effective transmission of closing load (large illustration on opposite page shows this design). Material is important, too. On smaller valves, bushings of bronze will help prevent stem seizing or galling. Look for ample thread engagement between bushing and yoke and between bushing and stem.

Packing Chamber should be large enough to insure long packing life. Valve packing must allow the stem to move within the bonnet but must not allow any fluid leaks between them. Well made packing, formed specifically for the packing chamber and correctly compounded for your pressure-temperature service conditions, has much to do with satisfactory valve performance. Valves with a positive backseat for re-packing while under pressure offer additional operating advantages.

Bonnet Joint of bolted construction (see Fig. 618 this page) is easiest to work with on medium or small size valves. But for lasting bonnet joint tightness, in high-temperature services (and for reduced size and weight), pressure-seal bonnet joint design is best—no flanges or bolting to periodically restress (see large illustration opposite page). Not all pressure-seal designs are alike, however. Avoid gaskets with small sealing surfaces and sharp edges that can be easily damaged and large threaded gasket loading mechanisms that are hard to disassemble and give unknown gasket compression.

Disk Guiding that properly centers the disk into the seat for positive shut-off regardless of position is important. Valve bodies with integrally cast guide ribs supporting disk throughout travel are best. Avoid designs which attempt to guide by installing spider in seat opening.

Seat-Disk Joint—An integral hard-faced seat is generally regarded as superior to screwed seat construction because it eliminates body-seat leakage and retains hardness under temperature. A hard-faced disk or disk of special alloy is desirable in high temperature services; but 13 per cent chromium stainless steel is an excellent all purpose material below 750° F.

Body Design with streamlined flow passage areas (opposite page) reduces wear-producing turbulence, decreases pressure drop and delivers maximum flow. Valves with streamlined body contours will often permit the use of smaller pipe and valve sizes. Angle valves (see Fig. 7517Y, upper right) have even less pressure drop.

For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame Street, W., Montreal 1, Quebec.

Edward Valves builds a complete line of cast steel stop, check, non-return, stop-check and gate valves for pressures to 10,000 lbs. available with flanged or welding ends. Below are illustrated a few of the major valve designs from this complete line.

Fig. 7517Y
Angle stop valve, 1500 lb at 850 F. (3600 lb WOG), with integral Stellite seat, Stellited disk, pressure-seal bonnet, welding ends. 2½" to 14".

Fig. 618
Globe stop valve, 600 lb at 850 F. (1440 lb WOG), bolted bonnet, flanged ends, integral Stellite seat, Stellited disk. Sizes 2½" to 6".

Fig. 607Y
Angle non-return valve, 600 lb at 850 F. (1400 lb WOG), with pressure-seal bonnet, integral Stellite seat, Stellited disk-piston, welding ends, sizes 8" to 14".

Fig. 611—Gate valve, 600 lb at 850 F. (1440 lb WOG), with hard-surfaced seats and wedge, ball bearing yoke, flanged ends. Sizes 2½" to 12".

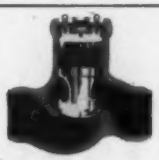


Fig. 4094Y—Horizontal check valve, 900 lb at 850 F. (2160 lb WOG), with integral Stellite seat, Stellited disk-piston, pressure-seal cover, welding ends. Sizes 2½" to 14".

Fig. 7514—Flite-Flow globe stop valve, 1500 lb at 850 F. (3600 lb WOG) or 2500 lb at 850 F. (6000 lb WOG), with extremely low pressure drop and other premium features. Sizes 10" to 18".

EDWARD STEEL VALVES
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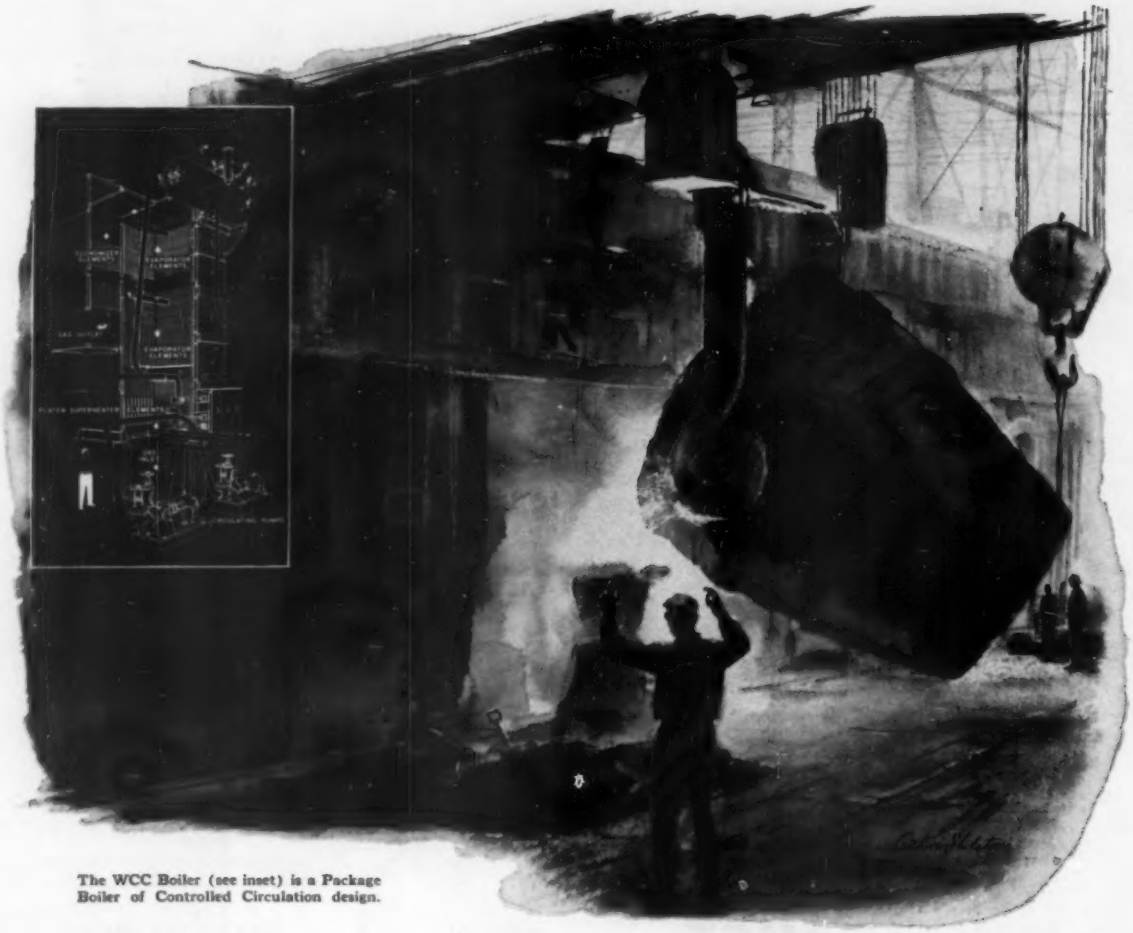
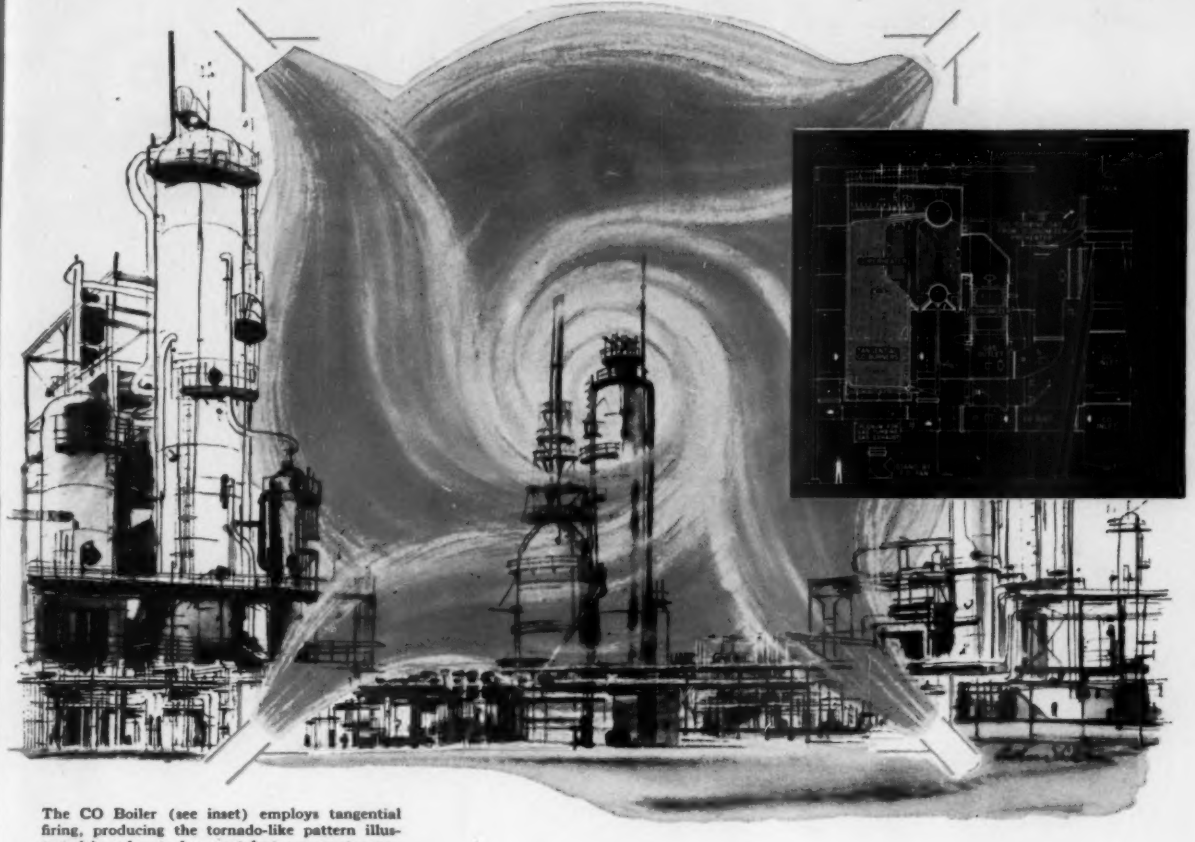
WASTE HEAT AND BY-PRODUCT STEAM WHEN

Though no two industrial processes are exactly alike, a great many produce hot waste gases or by-product waste materials. Often, they contain substantial amounts of energy which, when properly used, can provide a valuable addition to the fuel supply of a plant. C-E has had long and varied experience in taming and harnessing many kinds of waste and marginal fuels. At the steel mill pictured below and in refineries like the one at right, C-E boilers use just such fuels to provide dependable, low-cost steam.



The WCC Boiler (see inset) is a Package Boiler of Controlled Circulation design.

MATERIALS PROVIDE LOW-COST HARNESSED BY C-E



The CO Boiler (see inset) employs tangential firing, producing the tornado-like pattern illustrated in color, to burn catalyst regenerator gas.

As discussed on the opposite page, two interesting examples of waste heat "in harness" are the applications of specially designed C-E boilers to the exhaust of steel mill open hearth furnaces and to the catalyst regenerator exhaust of a refinery. In each case, the gases used are peculiar to the industry involved. In one instance, they are sticky and corrosive and offer only sensible heat. In the other, the gases are toxic and moist, and contain a lean measure of chemical heat in the form of carbon monoxide—in addition to sensible heat. In both cases, C-E advanced engineering has created boiler designs (see sketches) ideally suited to the heat source—boilers which provide maximum steaming capacity with minimum maintenance. Other C-E boiler designs in the waste heat category are in service using a wide variety of waste process gases — with and without chemical heat. In the area of marginal and by-product fuels, C-E has designed and placed in service a large number of boilers which burn such wastes as refinery sludge, wood shavings, sawdust, pith, rice and oat hulls, furfural waste, bagasse, peanut shells, grape skins, spent coffee grounds, black liquor and, of course, coke oven and blast furnace gas.

What all this adds up to is the fact that there is really no such thing as waste heat—there is only *wasted* heat. And there needn't be—because Combustion has the know-how and experience to put almost any potential energy source to work for you—to provide you with an extra dividend in the form of additional low-cost steam for your plant. Why not investigate harnessing a C-E boiler to your waste heat or by-product material? The amount of money it can save for you may be surprising.

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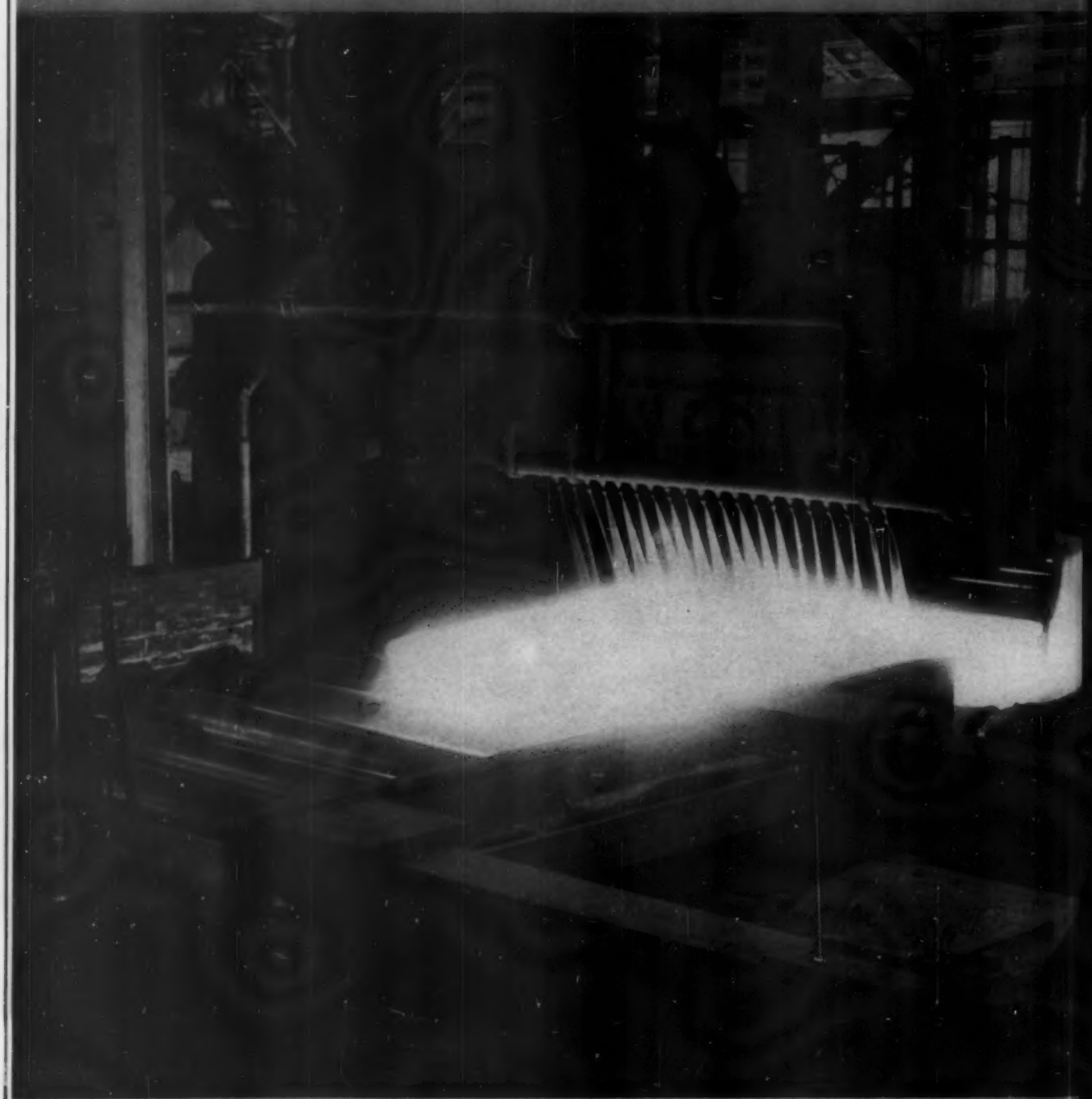
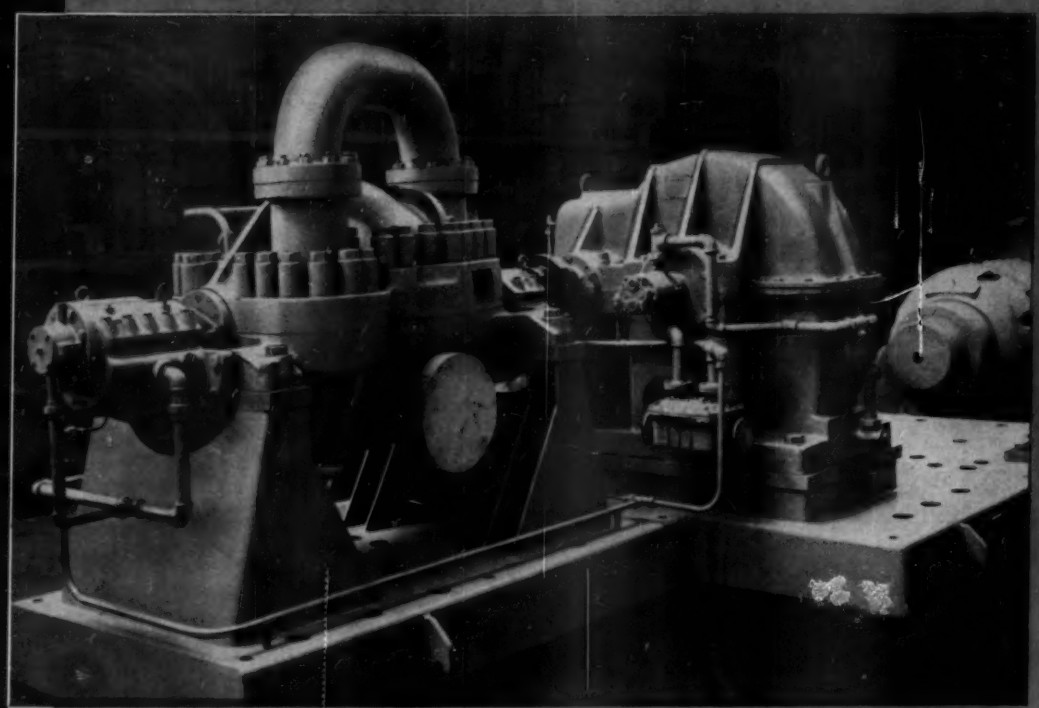


e descaling at Lukens Steel

Latest successful technique of high-pressure descaling is now being performed in this modern steelmaking facility designed by Mesta Machine Co.

The initial high-pressure descaling operation uses De Laval split-case multi-stage pumps as shown in the photograph below. Each pump supplies cold water at 1000 gpm and 1600 psig. Electric motors rated at 1750 hp drive the pumps through speed increasers which raise the speed from 1200 rpm to 4250 rpm.

De Laval pumps also serve Lukens on a 1200 psig descaling system in another section of the Coatesville, Pa. mill.



One of several arrangements available for descaling service at pressures of 1000-1200-1600 psig and capacities to 2200 gpm.

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Colver		Colver	"B"	Cambria (Pa.)
Indian Creek	Central Pennsylvania Medium Volatile	Melcroft	"B" or Miller	Fayette (Pa.)
Federal	Northern West Virginia	Federal #1	Pittsburgh	Marion (W. Va.)
Beckley	Southern West Virginia Low Volatile	Eccles #5	Beckley	Raleigh (W. Va.)
Sewell		Eccles #6	Sewell	Raleigh (W. Va.)
New River		Stotesbury #8	Pocahontas #4	Raleigh (W. Va.)
		Stotesbury #10	Pocahontas #4	Raleigh (W. Va.)
		Stotesbury #11	Pocahontas #4	Raleigh (W. Va.)
Pocahontas		Keystone	Pocahontas #3	McDowell (W. Va.)
Eagle	Southern West Virginia and Eastern Kentucky High Volatile	Beards Fork	Eagle	Fayette (W. Va.)
		Kopperston #1	Eagle	Wyoming (W. Va.)
No. 2 Gas		Kopperston #2	Campbells Creek	Wyoming (W. Va.)
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		Wharton #2	Hernshaw	Boone (W. Va.)

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C & I	1	N&S; Slack; Stoker; Nut	5000	Colver
B & O	1	M/R; N&S; Slack	1200	Indian Creek
Monongahela; B&O	3	Lump; Egg; Nut; Stoker; M/R N&S; Slack	12,500	Federal
C&O; Virginian	7	Scr. M/R; Stove; N&S; Slack	2500	Beckley
C&O; Virginian	7	Scr. M/R; Stove; N&S; Slack	1000	Sewell
C&O; Virginian	7	Stoker; M/R; Slack	2000	New River
C&O; Virginian	7	Stoker; N&S; Slack	2500	
Virginian	7	M/R; Slack	1800	
N & W	7	Egg; Stove; Nut; Stoker; M/R; N&S; Slack	7500	Pocahontas
Virginian	7	M/R; N&S	2900	Eagle
Virginian	8	M/R; N&S; Slack	3500	
Virginian	8	M/R; Nut; N&S; Slack	7000	No. 2 Gas
C & O	8	M/R; N&S	3500	Wharton
C & O	8	M/R; N&S	4000	

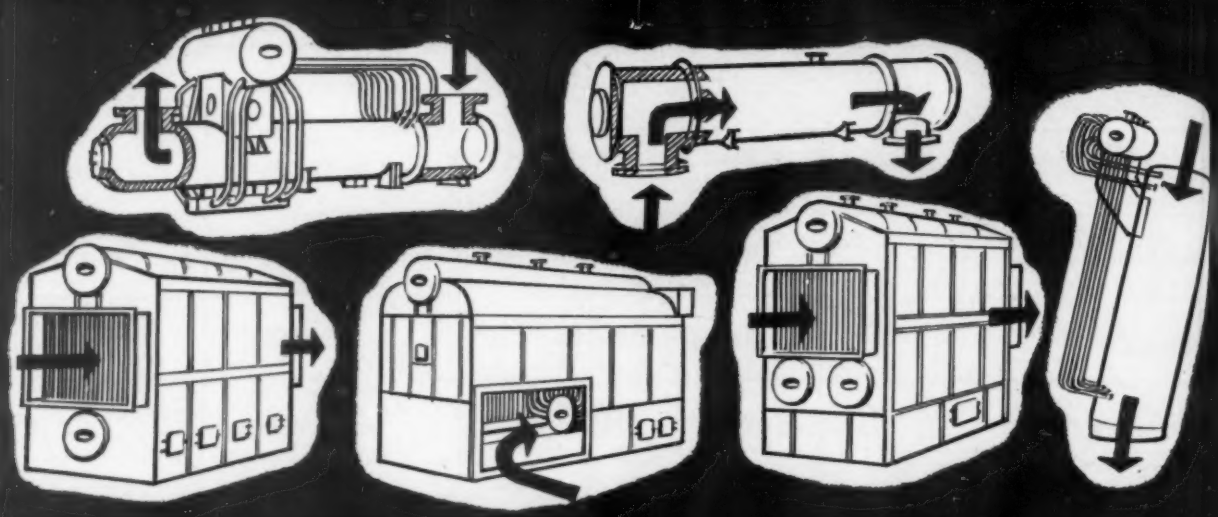
GAS AND FUEL ASSOCIATES

CLEVELAND • DETROIT • NEW YORK • NORFOLK • PHILADELPHIA • SYRACUSE

For New England: New England Coal & Coke Company For Export: Gardner, Curran & Bullitt, Inc.

Erie City HAS WHAT IT WASTE

~A COMPLETE LINE of FIRE and WATER TUBE BOILERS~



~USING THESE PROCESS GASES~

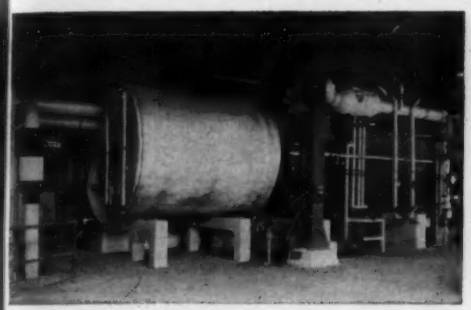
BLACK LIQUOR GAS • OPEN HEARTH GAS • INCINERATOR GAS
REFORMED GAS • ZINC ROASTER GAS
SODIUM SILICATE GAS • REVERBERATORY GAS • SO_2 GAS
NITRIC ACID GAS • GAS TURBINE EXHAUST

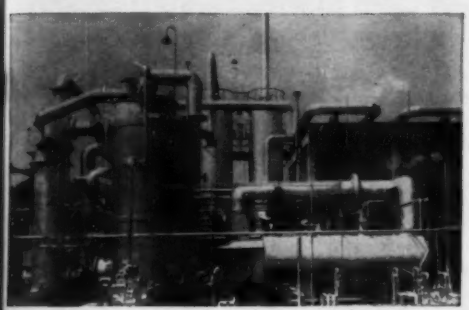
~AT THESE LEADING PROCESSING COMPANIES~

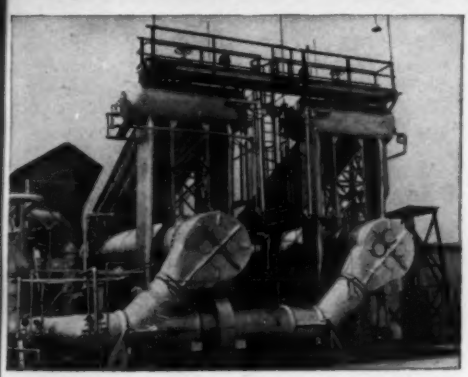
Adams Terminal Ammonia Co.
Advance Bag & Paper Co.
Allied Chemical & Dye Corp.
Allis Chalmers Mfg. Co.
American Cyanamid
American Oil Co.
American Rolling Mill
American Smelting & Refining Co.
Atmospheric Nitrogen Co.
Bethlehem Steel Corp.
Blaw Knox Corp.
Brea Chemicals, Inc.
Central Iron & Steel Co.
Chemical Construction Co.
City of Bridgeport, Conn.
Commercial Solvents Co.
Consolidated Chemical Co.
Continental Oil Co.
Diamond Alkali Co.
DuPont Co.
Eagle Pitcher Co.
Eastman Kodak Co.
General Chemical Co.
Gulf Oil Corp.
Jersey City Incinerator
Lion Oil Co.
Lowell Gas & Electric Co.
New York & Pennsylvania Co.
Olin Mathieson Chemical Corp.
Philadelphia Gas Co.
Reichold Chemicals
Shamrock Oil & Gas Co.
Sherritt Gordon Mines Ltd.
Southern Kraft Corp.
St. Helens Pulp & Paper Co.
Stauffer Chemical Co.
Texas Eastman Co.
Tidewater Associated Oil Co.
Union Bag & Paper Power Corp.
Union Oil Co.
West Virginia Pulp & Paper Co.

TAKES FOR EFFICIENT----

HEAT RECOVERY







Two factors combine to make Erie City Iron Works your reliable headquarters for specialized applications of waste heat recovery systems. - - - First, is our eagerness to cooperate with Process Engineers - - - whether the problem is routine or highly involved. As a result, we have gained valuable experience in waste heat recovery for modern processing that is unequaled in the steam generating field. - - - Second, Erie City Engineers have available a complete line of standardized fire- and water-tube boilers and the know-how to apply them to meet specified conditions. Erie City Waste Heat Recovery Systems are being used with all kinds of gases throughout the broad field of processing. We welcome the opportunity to work with your engineers on any waste heat recovery problem, or for that matter any steam generating problems.

Write for our comprehensive bulletin SB-6092J.

You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS · Erie, Pa.

•STEAM GENERATORS •SUPERHEATERS
•ECONOMIZERS •AIR PREHEATERS
•WASTE HEAT BOILERS •FIRE AND WATER TUBE PACKAGE BOILERS
OIL AND GAS BURNERS • STOKERS • PULVERIZERS

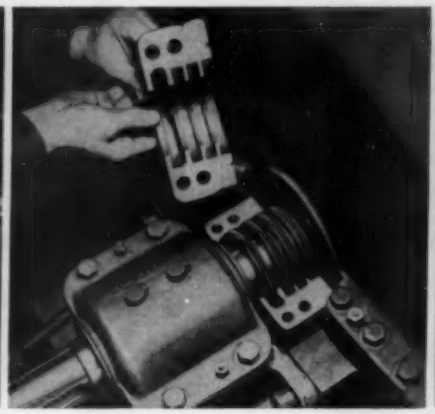
ERIE CITY Since 1840

For more data circle 314 on Post Card

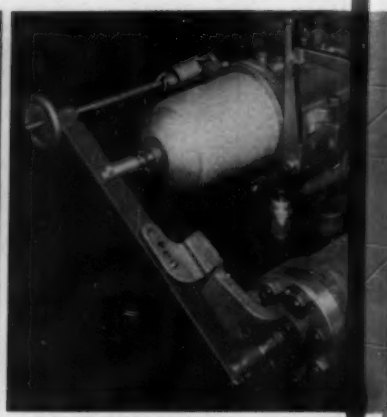
Economical in operation...
Dependable always

ELLIOTT

Precise alignment of shaft, through true centerline support, permits smooth and dependable operation at all operating temperatures. The entire rotor assembly is dynamically balanced.



Accessible shaft-seals simplify maintenance and routine inspection. Shaft surface under packing glands is stainless steel. Covers are readily removable without disturbing the upper-half casing.



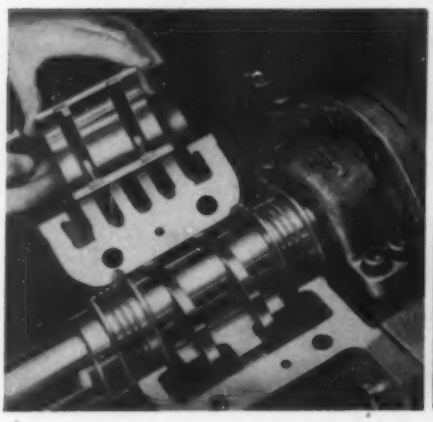
Simple, Positive direct-acting speed-governing system is dependable, weather-proof, accurate. Separate trip gives positive overspeed protection, and it may be easily reset against line pressure.

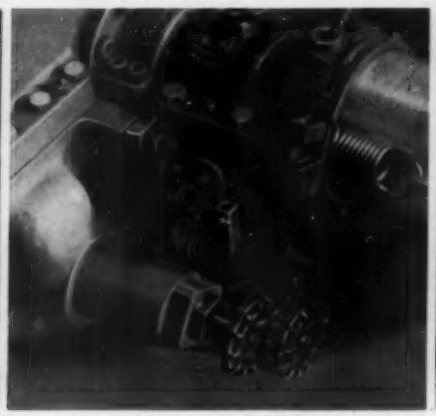
Only ELLIOTT Turbines give you all these PLUS features

By separating the pedestal-mounted exhaust-end bearing from the hot turbine casing, the temperature distortion is minimized, and the vertical shaft movement is thereby eliminated.

Steam-saving hand valve with pilot, which can be opened against full steam pressure, reduces steam consumption at partial loads. This feature is available on all sizes of Elliott YR steam turbines.

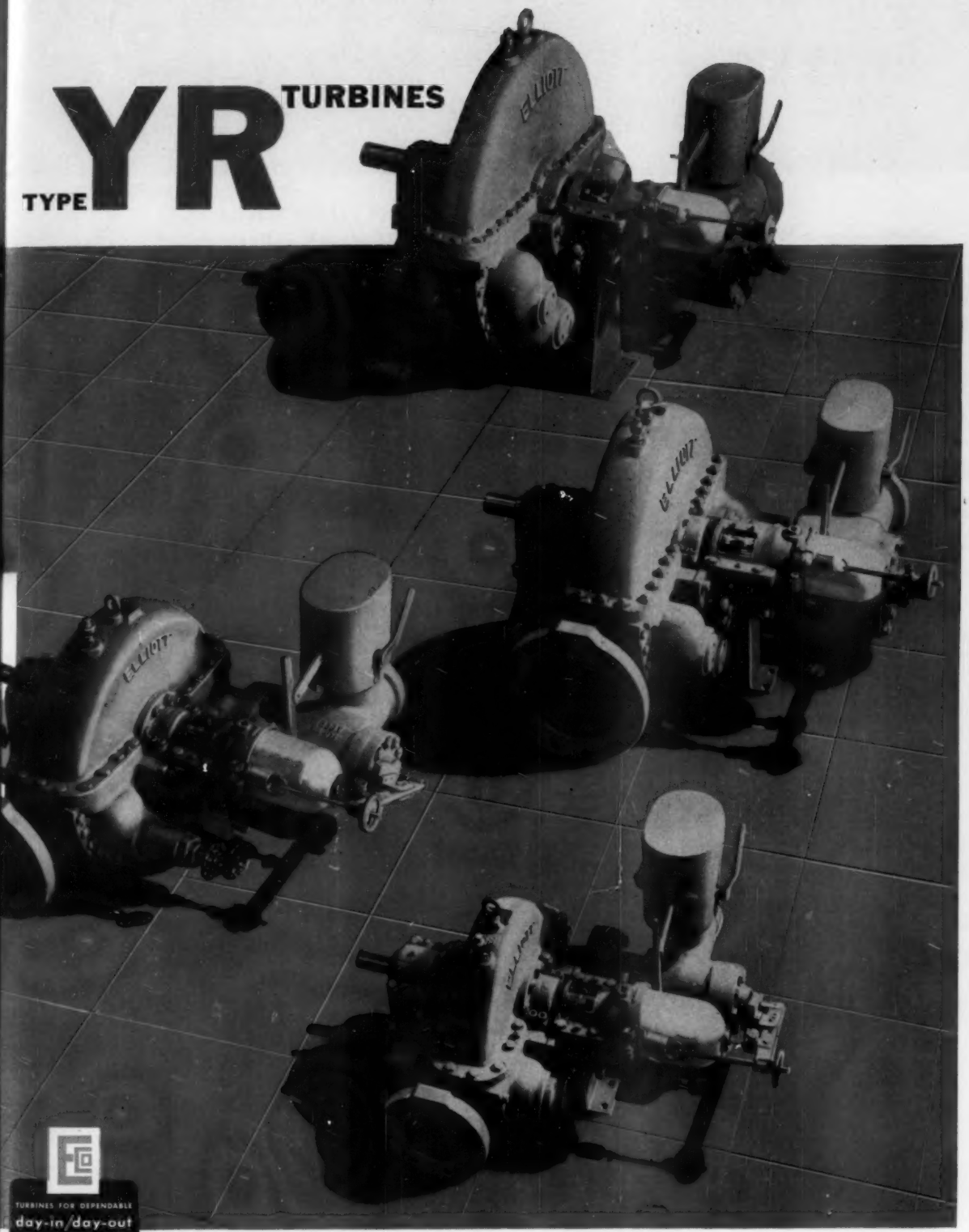
All-weather protection is standard for Elliott YR turbines. They shrug off heat, dirt, snow, moisture or contaminated atmosphere. Stainless steel exposed parts are furnished for extreme conditions.





In addition to the units illustrated here, Elliott makes single-stage turbines in special frames, reduction gears, multistage mechanical drive turbines to 50,000 hp, and turbine-generators ranging through 44 mw.

TYPE YR TURBINES



TURBINES FOR DEPENDABLE day-in/day-out SERVICE

H9-1

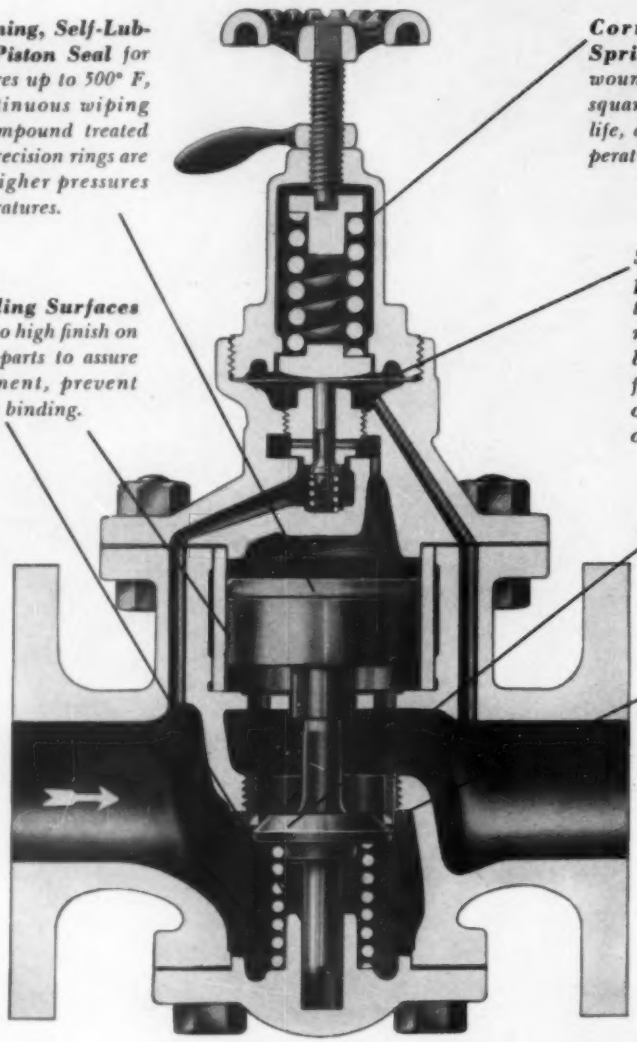
ELLIOTT Company JEANNETTE, PENNA.

For more data circle 515 on Post Card

HERE'S WHY YOU GET EXTRA VALUE COMPLETE LINE OF

Self-Cleaning, Self-Lubricating Piston Seal *for temperatures up to 500° F, gives continuous wiping action. Compound treated cast iron precision rings are used for higher pressures and temperatures.*

Long Guiding Surfaces *are ground to high finish on all moving parts to assure true alignment, prevent cocking and binding.*



Corrosion-Resistant Springs *are accurately wound with ends ground square. Maximum spring life, even under high temperature conditions.*

Stainless Steel Diaphragm *responds instantly to any flow change—eliminates stuffing boxes and bellows seals. Diaphragm's full travel is less than its own thickness, can't be over-stressed.*

Single Seated Construction *assures positive dead end shut off.*

Stellited Seating Surface *combined with a hardened stainless main valve provides ultimate in erosion resistance.*

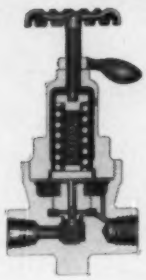
Interchangeable parts *May be replaced without taking valve body off the line, and, even more important, without machining.*

Cutaway of Leslie internal pilot, piston operated reducing valve class LY, shows typical Leslie quality construction features. Throughout the Leslie line, features like these and others presented on the next page are your assurance of lower operating costs and long life performance. They are based on over 50 years of leadership in designing and manufacturing quality regulators.

Internal pilot piston operated reducing valves are available for steam services, up to 2500 lbs., ASA, reduced pressure ranges to 1400 psi. Sizes ½ to 6". Cast iron, bronze, steel or alloy steel construction.

LC-9

IN LESLIE'S REDUCING VALVES AND REGULATORS



LESLIE SMALL FLOW REDUCING VALVES

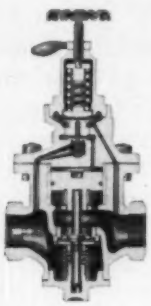
Leslie small flow reducing valves are used in pilot plant operations, plastic molding presses, laboratory units, gland sealing, steam sterilization and atomizer units and wherever control of small flows of steam, air, gas or non-corrosive liquids are a problem.

These ½" valves feature simple, direct operated design with screwed or bolted adjusting spring assembly for easy access to the internal parts. No stuffing boxes or fussy seals.

PRESSURE-TEMPERATURE RANGES

BODY MATERIALS AND CONSTRUCTION	CLASS	MAX. INLET PRESSURE PSI		MAX. TEMP. °F.	MIN. PRESS. DROP PSI	REDUCED PRESS. RANGE PSI
		STEAM	COLD LIQUID AIR OR GAS			
BRONZE Screwed Bonnet	LCA	—	400	150	10	5-285
	LCB LCC LCD	300	400	550	10	10-285
	LCLA	—	400	150	10	2-35
	LCLB LCLC LCLD	300	400	550	10	2-35
STEEL Thru Bolted Bonnet	LCL(B)S LCL(C)S LCL(D)S	600	1000	750	10	25-400 10-50

LESLIE REDUCING VALVES FOR AIR OR GAS SERVICE



Leslie internal pilot, piston operated reducing valves offer a combination of accurate regulation and low maintenance service, and are used for accurate control of air or gas with inlet pressures up to 400 psi at 150° F.

Accuracy of regulation is comparable to instrument control with full flow for equivalent pipe size. Valves feature 99% accuracy of regulation at rated capacity.

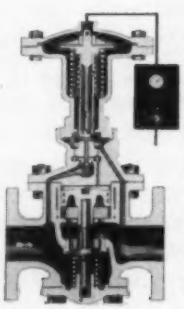
Positive, bubble tight shut-off is provided by resilient, single seated valve disc. Fully guided main valve, stainless steel diaphragm and non-corroding internal springs assure long, trouble-free operation.

PRESSURE RANGES AND CONSTRUCTION

CLASS	SIZE (Inches)	MAXIMUM INLET PRESSURE & TEMP.	REDUCED PRESSURE RANGE-PSI		BODY MAT'L.	END CONNECTIONS
			MIN.	MAX.		
LA-5 LAE-5	½-4	25-400 psi 150° F max.	5*	285	Bronze	½-2" 300 lb. screwed ½-4", 150 & 300 lb. MSS flanged
LAK LAEK		25-400 psi 150° F			Cast Iron	½-2" 250 lb. screwed 1½-3" 250 lb. ASA flanged
		25-175 psi 150° F max.				1½-4" 125 lb. ASA flanged

*5% of inlet pressure over 100 psi

REMOTELY ADJUSTED REDUCING VALVES



Operating characteristics of Leslie remotely adjusted reducing valves are identical to manually adjusted types. The remotely adjusted reducing valve is adjusted to the desired pressure setting by air pressure from an air loading device. The constant loading force on the upper diaphragm opens the pilot valve and is balanced by a constant reduced pressure proportional to the loading force.

The air loading panel eliminates hazardous or inconvenient adjustments and provides fast means of readjusting pressure to meet changing requirements.

REMOTELY ADJUSTED REGULATING VALVES

TYPE	SIZES AVAILABLE (Inches)	BODY MATERIALS AVAILABLE	INLET PRESSURE RANGES (PSI)	MAXIMUM REDUCED PRESS. (PSI)
Small flow, internal pilot actuated, diaphragm operated	⅛, ¾, ½	Bronze	20-300 psi 550° F steam 20-400 psi 150° F air	175
Internal pilot actuated, piston operated	½ - 6	Cast Iron Bronze Cast Steel	25 psi up to 600 psi, 750° F	175
Internal pilot actuated, piston operated for high pressure service	½ - 3	Cast Steel and Alloy Steels	300 psi up to 3000 psi	700

For sizing and capacity data on this Leslie line of valves, contact your Leslie engineer or write for Bulletin 5302B.

TRADE LESLIE MARK

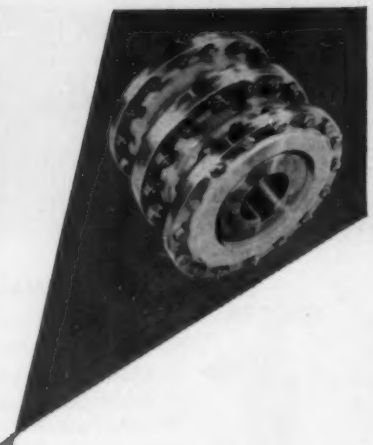
REGULATORS and CONTROLLERS

Leslie Co.; 501-B Grant Ave., Lyndhurst, New Jersey

Over 275 Factory-Trained Engineers At Your Service—Nationwide!

For more data circle 516 on Post Card

the basic coupling principle that couldn't be improved . . .



This principle makes every Fast's coupling . . . large or small . . . out-perform all others

The principle embodied in Koppers gear-type, self-aligning Fast's couplings couldn't be improved by anyone. Throughout industry, Fast's couplings are accepted as the most dependable couplings on the market. Experience has proved that they frequently *outlast the equipment* they connect.

Fast's couplings are sufficiently comprehensive in types, sizes and versatility to meet almost every known need for couplings. Available in forged steel for shaft sizes from ¾″ to 6⅜″ and in cast steel for shaft sizes from 5½″ to 32″.

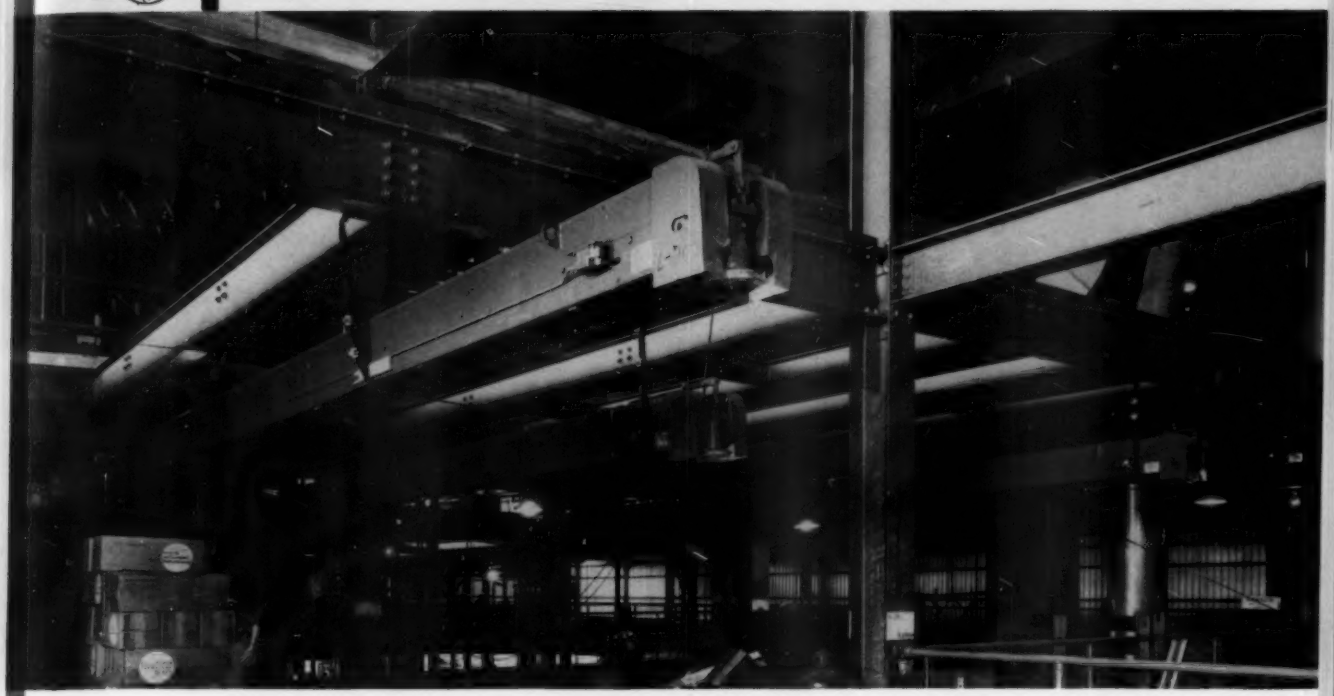
Nearly 40 years of coupling experience guarantees that Koppers can supply the right coupling engineered for a given application. For the booklet describing Fast's couplings applicable to your equipment, write today to: KOPPERS COMPANY, INC., Fast's Coupling Department, 5209 Scott Street, Baltimore 3, Maryland.

KOPPERS

THE ORIGINAL **FAST'S Couplings**

Engineered **Products Sold with** ***Service***

For more data circle 517 on Post Card



Vulcan T-30's have 30- and 37-foot travels. Motors, mounted at the boiler end, facilitate maintenance, avoid interferences, yet are away from the heat of the boiler. Eddystone Station's Unit 1 has a capacity of 2,000,000 lb/hr at 5000 psig and 1200°/1050°/1050°/F . . . uses C-E Sulzer Monotube Steam Generator.

Vulcan Selective-Sequence system provides Eddystone Station with precision soot blowing

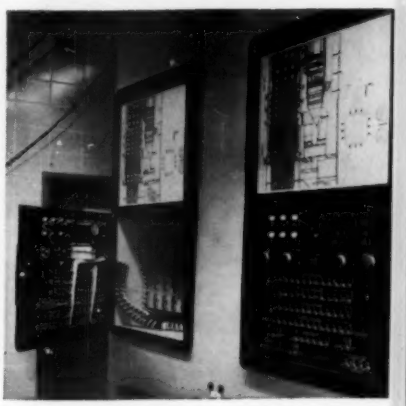
When Unit 1 of Philadelphia Electric's Eddystone Station went into operation, a Vulcan Selective-Sequence system was accurately controlling all soot blowing.

Selective-Sequence systems were chosen for both units 1 and 2 at this super-critical station because they assure positive, dependable boiler cleaning . . . make the most efficient use of the blowing medium.

Vulcan long retractables speed cleaning. With dual-motor drive, Eddystone's T-30's clean uniformly; minimize the danger of tube cutting or erosion. Low rotating speed increases range and penetration of cleaning, decreases wear, eliminates whip, and permits proper cleaning with faster traversing speeds.

Half-'tracts with 19-foot travel, wall deslaggers, and air pre-heater controls are also used.

Panel provides centralized control of soot blowing at Eddystone. With the Vulcan SSC-120 Selective-Sequence controller, each blower can be operated four times during a schedule, or there can be four different schedules. Operator easily monitors the program without leaving the panel, or modifies the sequence without time-consuming wiring and piping changes.



For details, write for Bulletin 1039 on Long Retractable Soot Blowers, Bulletin 1029 on Automatic Soot Blowing Systems, Bulletin 1034 on Wall Deslaggers.

Copes-Vulcan Division
BLAW-KNOX COMPANY
Erie 4, Pennsylvania

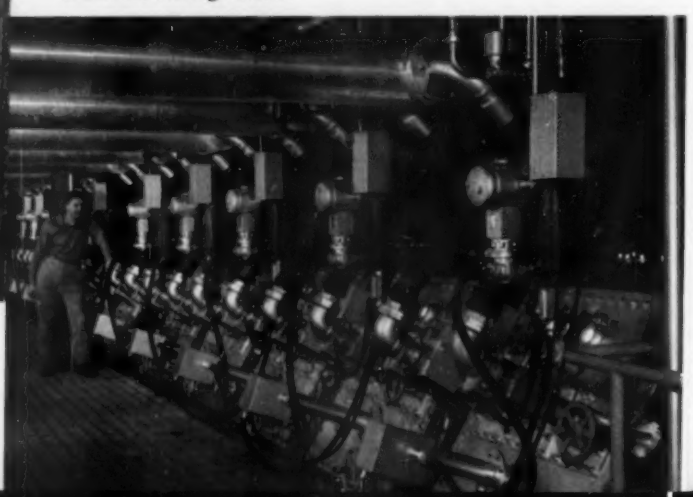
For more data circle 518 on Post Card

One TURBO FURNACE

The Riley Turbo Furnace Boiler is dominant structure at Sterlington Steam Electric Station near Monroe, Louisiana.

Ten of twenty Riley Directional Flame Turbo Furnace Burners. Opposed firing produces turbulent flame at uniform level across full 56 feet of furnace width. Each burner is equipped with remote automatic shut-off and flame sensing devices.

Weather resistant, colorful porcelainized panelling covers setting buckstays.



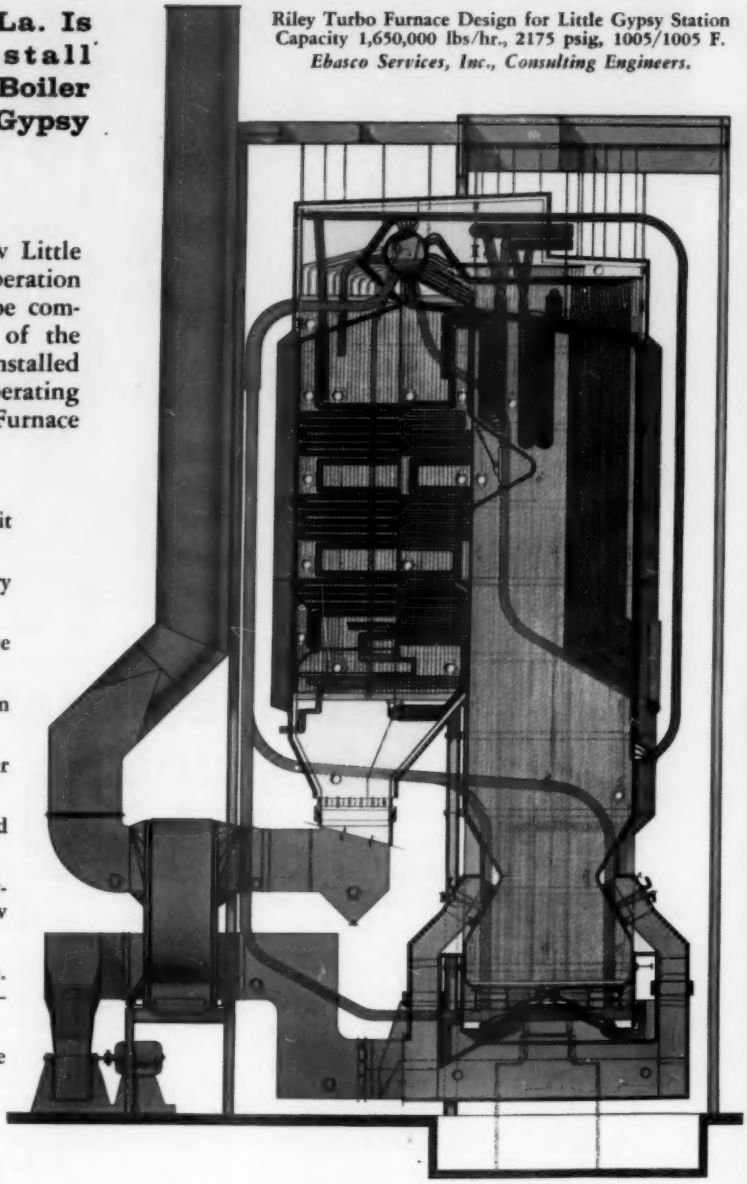
Leads to Another-

Performance at Sterlington, La. Is Basis For Decision To Install 1,650,000 lb/hr Turbo Furnace Boiler At Push-Button Operated Little Gypsy Steam Electric Station.

Louisiana Power & Light Company's new Little Gypsy Station is scheduled to go into operation early in 1961. This pioneering plant will be completely push-button operated. The design of the 1,650,000 lb/hr Riley Turbo Furnace to be installed is based upon the following exceptional operating characteristics of the 1,550,000 lb/hr Turbo Furnace at Sterlington Steam Electric Station.

- Low air heater exit gas temperatures — high unit efficiency.
- Low forced draft fan pressures — low auxiliary power.
- A flat superheater and reheater metal temperature traverse across full furnace width.
- Primary and reheat temperatures maintained from below 50% load to full load.
- With bottom firing — full utilization of water wall surfaces.
- One level firing provides ease of observation and operation.
- Gas burns with luminous flame with similar furnace temperatures as coal — hence, quick and low cost conversion to coal firing is possible.
- With coal firing flyash is reduced to a minimum. With continuous slag tapping and reinjection — carbon loss is negligible.
- With coal firing an exceptionally clean furnace is maintained.

Riley Turbo Furnace Design for Little Gypsy Station
Capacity 1,650,000 lbs/hr., 2175 psig, 1005/1005 F.
Ebasco Services, Inc., Consulting Engineers.



Monitoring at Sterlington Sets Stage For Complete Automation at Little Gypsy

At Sterlington, digital scanning, logging and computation of temperature conditions and other operating factors of furnace, boiler, turbine, generator, feedwater, and auxiliaries are the basic elements for complete automation of the Little Gypsy Steam Electric Station. Procedure, with audible and visible alarms, enables one operator in a centralized control room to make proper decisions for safe and efficient operation of entire plant. The operating characteristics of Riley Turbo Furnace Boilers are ideal for automatic push-button plant operation.

A survey of your plant by qualified consulting engineers could show ways of making substantial savings in your power costs.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

RILEY STOKER CORPORATION, WORCESTER, MASS.

Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, Seattle, St Louis, St. Paul, Syracuse, Worcester.

Bailey Meters and Controls for Combustion, Feed Water, Steam Temperature and Condensate at Moores Park Station, City of Lansing, Michigan.

How Bailey makes steam operating duties a pleasure—

Fingertip Controls, convenient indicators and trend recorders make steam control room operating duties a pleasure. You get this bonus for your operators when you specify Bailey Meters and Controls.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs.

Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

A133-1

BAILEY METERS

Instruments and controls for power and process

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

For more data circle 520 on Post Card

HELPFUL BULLETINS

LIGHTING

101 Floodlight Data in Brief — Pocket-sized Bulletin 2714 is a 184-pp miniature edition of company's popular floodlight catalog, and includes all original material. Covers selection of floodlights, general purpose floodlights, heavy duty models, mercury vapor floodlights, special types, lighting for hazardous locations, searchlights, floodlight poles, accessories. Also includes installation suggestions and lighting calculations, Crouse-Hinds Co.

102 Industrial Lighting Data — New specifications for incandescent and mercury vapor uplight porcelain enamel and aluminum high mounting units, "all-white" incandescent specs and many upward revisions in specifications for industrial fluorescent fixtures are included in the 44-pp 1959 edition RLM Specifications Book. Contains complete specifications for 14 basic types of most widely specified industrial lighting units. RLM Standards Institute, Inc.

MECHANICAL POWER TRANSMISSION

103 On Gear Motors — Technical information on horizontal and vertical mounted gear motors with capacity up to 125 hp and a variety of output speeds from 780 rpm to 1.2 rpm is presented in 32-pp Bulletin J-17. Load characteristics table and selection table are included. Hewitt-Robins, Inc.

104 Gear Motor Guide — Featured in 18-pp Bulletin 5806 is detailed selection and application information on StraitLine all-motor and integral type gear motors. Application classification tables, selection tables, conversion table, sprocket diameters, load capacity table, and dimensional data and diagrams are included. Western Gear Corp.

105 Drives for Calendars — Eight-pp Bulletin GEA-6910 describes a line of adjustable-speed drive equipment for calenders. Advantages are detailed and selection table listing important features is included. General Electric Co.

106 Low Cost Adjustable Speed — Bulletin GEA-6806, 16 pp, describes the ¼ to 25 hp line of Polydyne mechanical drives for obtaining adjustable speed straight from a-c power. Discusses principles of operation, configurations and features, and includes mounting positions, rating tables and available accessories. Also covers benefits of mechanical adjustable speed drives and how to select Polydyne units. General Electric Co.

107 On Worm Gear Sets — Basic data needed for accurate selection of Delroyd worm gear sets is provided in 24-pp Catalog 3800. Illustrated with explanatory drawings, it contains essential information on advantages of worm gearing, as well as selection tips, design data, horsepower ratings. Tells how to calculate bearing loads. De Laval Steam Turbine Co.

108 Variable-Speed Drive — Eight-pp Bulletin 195 describes features and applications of variable-speed drives. Includes detailed information on horsepower, duty, speed variation, mounting styles, enclosures, and electrical characteristics. Sterling Electric Motors, Inc.

109 Adjustable-Speed Drive — Eight-pp Bulletin K-250 discusses adjustable-speed and drive control problems. Describes typical applications along with methods and types of remote and automatic control, variable speed bedplate assemblies. The Cleveland Worm & Gear Co.

110 Welded Steel Pulleys — Eight-pp Book 2540 describes a hydro-expansion-formed belt conveyor pulley designed to increase conveyor belt life. Gives detailed engineering and selection data, information on lagged pulleys, shaft and pulley assemblies. Link-Belt Co.

111 Chain Drives and Conveyors — Bulletins 59126 (24 pp), and 59127 (28 pp (outline installation, operation and maintenance procedures for chain drives and chain conveyors and elevators. Both bulletins are handy pocket-size editions containing practical information on how to install, operate, maintain and extend life of the chain drives. Chain Belt Co.

INSULATION

112 Foamed Plastic Insulation — Featured in this product bulletin is a flexible foamed plastic insulation designed to stop condensation and save heat on air-conditioning, refrigeration and plumbing and heating lines. Tables of dimensional data are included. Armstrong Cork Co.

113 Pipe Insulation — Three customized systems of underground pipe insulation are described in this bulletin: a cased thermal concrete, an insulating concrete conduit, and a water resistant monolithic conduit. Gives features of each and lists additional qualities common to all. Concrete Thermal Casings, Inc.

PUMPS, COMPRESSORS

115 Vertical Turbine Pump — Featured in 16-pp Bulletin 2400-B1 is a line of ultra high flow vertical turbine pumps. Design improvements which result in broader coverage and higher efficiencies are illustrated. Worthington Corp.

116 Rotary Pumps — Internal gear rotary pumps for handling hazardous liquids are illustrated and described in this product bulletin. Performance chart is included, as well as dimensional tables and diagrams. The Wayne Pump Co.

117 Refining Industry Pumps — Sixteen-pp Catalog R-59 describes a line of pumps designed for the refining and petrochemical industries. Design features are illustrated through cutaway views, and selection tables giving essential data are provided in this catalog. Wilson-Snyder Works, United States Steel.

118 Submersible Sump Pump — Eight-pp Bulletin 5300 describes features and operation of a submersible sump pump which can be lowered into a sump pit for temporary service or permanently installed for continuous service. Performance and dimension tables are included. The Deming Co.

119 Rotary Air Products — Application ideas for company's line of air motors, air compressors and vacuum pumps are illustrated in 12-pp Bulletin APP-459. Photos and diagrams show details of operation and design. Gast Mfg. Corp.

120 Air-Cooled Compressors — Sixteen-pp Bulletin A-56 illustrates and describes a line of air-cooled compressors for a variety of applications in industry. Cross-section drawings and a complete run-down on all components included. Joy Mfg. Co.

121 Packaged Field Compressor — Six-pp Bulletin 171 describes a heavy-duty packaged compressor for single or two-stage applications where greater horsepower is required in a two cylinder machine Sizes range from 200 to 350 bhp. Dimensional data and specifications are included. Clark Bros. Co.

PACKINGS, GASKETS

122 Molded Cups — Latest types of molded cups for pump pistons, hydraulic service and for pneumatic equipment are described in Bulletin AD-145. Details construction, recommended service and available sizes. The Garlock Packing Co.

123 Rugged Gasketing — How to reduce gasketing costs by using Armalon (TFE-fluorocarbon impregnated felt) is told in this bulletin. Gives data on characteristics of Armalon; lists specific applications where this gasketing material performs to best advantage; provides seven case histories on service performance of Armalon gaskets under extreme conditions; and includes information on sizes, thicknesses available. Fabrics Div., E. I. du Pont de Nemours & Co. (Inc.)

VALVES, PIPING, FITTINGS

124 Ductile Iron Valves — Strength, corrosion resistance and other advantages of ductile iron valves are detailed in this 8-pp bulletin. Properties and characteristics of ductile iron are given. Also provided is information on types and sizes of valves available in this metal and suggested applications. Walworth Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 133 and 134.

125 Designed for Ductile Iron — Introduced in 8-pp Form 1010 is the Pipe-Pal line of gate valves designed specifically for ductile iron. In addition to listing specifications, pressure-temperature ratings, and dimension and material charts, it describes new applications and includes dis-

cussion of engineering properties of ductile iron and micro-structure comparisons with gray iron. The Ohio Injector Co.

126 Coated Valves — Eight-pp Bulletin V-614 describes coated lubricated plug valves which provide chemical resistance to both inorganic and organic agents. Includes description of coating properties, tables of recommended applications and photo-illustrations showing typical installations. Rockwell Mfg. Co.

127 Improved Plug Valves — Design features and performance advantages of company's non-lubricated, bearing mounted plug valves are detailed in 20-pp Catalog V-58. Illustrated explanation of valves' operation, dimensional data and diagrams are included. Hydril Co.

128 Hydraulic Valves, Accessories — Twelve-pp Catalog 3000 covers filters, check valves, unloading valves, relief valves and fuses for hydraulic power systems. The filters are rated for hydraulic pressures to 5000 psi, valves to 3000 psi. Information provided includes dimensions and pressure drop charts. Waterman Engineering Co.

129 Safety Valve — Bulletin F-47 describes a safety shut-off valve originally developed for service station use, but applicable with hazardous liquid lines of all types. It is designed to shut off automatically if a break in the pipe line occurs. Bulletin covers features of the valve, applications, engineering data and economical operation. OPW-Jordan.

130 Tempered Glass Pipe — Detailed information on Kimax tempered industrial glass pipe and fittings is presented in this 16-pp bulletin. Dimensional diagrams are included, as well as tables listing sizes, and a section of technical data. Owens-Illinois Glass Co.

131 Seamless Fittings — Twelve-pp Bulletin FB-78 is a guide to material selection of carbon, alloy and stainless steel welding fittings and flanges. Covers specifications and analyses, effects of alloying elements, mechanical properties and arc welding. The Babcock & Wilcox Co.

132 Expansion Joints — Six-pp Bulletin EJC-591 covers nomenclature and selection of S-R expansion joints. Advantages are detailed, and temperature ratings and other data included. Badger Mfg. Co.

133 Teflon Molded Shapes — Bellows, flexible couplings and expansion joints made of Teflon are described in Bulletin A-56-1. Pressure-temperature charts, and detailed specification and dimensional data given. John L. Dore, Co.

HEATING, AIR CONDITIONING

135 Unit Heaters — Design and operating features of direct fired unit heaters for oil, gas and dual fuel are shown on a large cutaway view in this product bulletin. Dimensional and engineering data tables are included. Jackson & Church, Div., York-Shipley, Inc.

136 Conditioner Units — Design features of Climate Makers, based on the building block principle, are detailed in 60-pp Catalog AHV-59. Blower and frame sections and other components are described. Engineering information provided includes fan capacities, direct expansion cooling capacities, and coil data, chilled water cooling capacities, chilled water coil data, mean effective temperature, psychometric data, steam and hot water heating capacities, air friction tables, water friction tables. Airfan Engineering Co.

137 Packaged Conditioners — Eight-pp Bulletin 8525 on packaged air conditioners illustrates their design and construction features. Capacities and physical data are tabulated for both air-cooled and water-cooled units. Industrial Div., America-Standard.

138 Air Conditioners — Eight-pp Bulletin 9127 describes low pressure Inductor air conditioners for perimeter air conditioning of multi-room buildings. Construction and operating features are detailed, and tabular data such as heating coil capacities, gravity heating capacity, hot water and steam heating capacity factors, and water friction included. Industrial Div., American-Standard.

ELECTRICAL

139 Network Transformers — Sixteen-pp Bulletin GEA-5024A describes features and advantages of network transformers for a-c secondary network systems. Discusses importance of core and winding design, and includes photos and diagrams illustrating other features. General Electric Co.

140 Individually Enclosed Breakers — To aid in selecting Urelite individually enclosed low-voltage power circuit breakers, 8-pp Bulletin S-4261-2B describes engineering advances incorporated and provides application data. Outlines such features as visible break, closed-cover drawout, simple inspection and removal, manual quick-make, others. Also includes chart which details ratings, overcurrent devices and accessories available. Other charts give dimensions, coil types etc. I-T-E Circuit Breaker Co.

141 Voltage Regulators — Application, description, selection, weights, dimensions and connection diagrams are given in 60-pp Bulletin GEC-1450A describing company's dry type and liquid filled voltage regulators. Facts about voltage and importance of proper voltage control are covered, and photos and diagrams are included. General Electric Co.

142 Transmission Towers — Trends in power transmission and tower design are described in Bulletin 2570. Outlines and illustrates transmission tower features and anchor systems. Blaw-Knox Co.

143 Rubber Power Cable — This 32-pp catalog contains detailed information on design features, insulations, and performance highlights of company's butyl rubber power cable. Includes data on available constructions, ampacity and installation data. Anaconda Wire & Cable Co.

144 Wiring System Standards — Informative data on wiring and wiring system standards is in Technical Bulletin RCT-102. It features sections on automation, conduit systems, troughs, trays, ladders, bus ducts and other products and wiring methods. Also includes recent bibliography on subject. Rome Cable Corp.

145 Protecting Battery Investment — Detailed instruction on motive-power battery installation and maintenance are given in 20-pp Form 1982. Included are recommendations on storage procedures and routine repairs, as well as checklists of spare parts and tools. This book serves as a refresher in battery and charging station procedures and is illustrated throughout with charts, photos and drawings. General rules of maintenance — summarized in eight lines — are covered in detail. Also included are hints and practical tips on what to do to keep batteries at peak form. Exide Industrial Div., The Electric Storage Battery Co.

146 Motive Power Batteries — This 48-pp general service manual details operation, maintenance, charging, trouble-shooting, and repair of motive power batteries. Profusely illustrated with photos, diagrams, tables, and charts, the manual covers basic battery theory and operating principles and explains various charging methods. C & D Batteries, Inc.

147 Meter Buyers' Guide — Bulletin GEC-1400B, 64 pp, provides up-to-date information on single-phase and poly-phase watthour meters, watthour demand meters, meter sockets and water-heater time switches. This 1959 edition of company's meter guide features a quick-reference selection chart on standard meter applications and an index covering references to proper mounting equipment. Application indices, product data, ordering tips, pricing information, service plans are included. General Electric Co.

MATERIALS HANDLING

148 Better Fly Ash Handling — How labor requirements were reduced and sanitary conditions improved at one plant by installation of a pneumatic conveying system to handle fly ash is related in Bulletin ER-49-2. Design and performance of the pneumatic system and component equipment are detailed. Fuller Co.

149 Wire Rope and Slings — Seven products in this company's wire rope and sling division are presented in five recently published bulletins. Each describes applications and provides specifications and selection data. Products covered include plastic-core and spring-core types, cable laid slings, fittings, super strength wire rope. Jones & Laughlin Steel Corp.

INSTRUMENTS AND CONTROLS

151 Selector Station — Product Specification P99-1 presents company's selector station which provides for adjustments for remote manual trimming of pneumatic control systems and for transferring from automatic to manual operation. Detailed descriptions of 32 standard types, classified according to application, included. Bailey Meter Co.

152 Indicators, Controllers — Bulletin 65 presents electronic self balancing indicators and indicating controllers which indicate any process variable convertible to an electrical quantity and may be connected to multi-point switches. Potentiometer and bridge type units are described. Illustrations show design simplicity. Thermo Electric Co., Inc.

153 Centralized Controls — Water conditioning and ion exchange systems control assemblies are illustrated and described in 12-pp Bulletin 4543. Covers panels and cubicles containing centralized instrumentation for automatically controlling, recording, signalling and monitoring system operations. The Permutit Co.

Another addition to the Vogt line
of TOP QUALITY valves . . .
Forged Steel
WELDED BONNET
GENERAL
GP
PURPOSE
Gate and Globe
VALVES
150-800 Pounds Service
To eliminate forever potential body-bonnet leaks, Vogt engineers have developed these new General Purpose valves with seal welded bonnet joints.
This new addition to the world's most complete line of forged steel valves incorporates all the features of other Vogt GP valves—hard faced seats, hardened stainless steel wedges, drop forged pressure parts, and the numerous other advantages of Vogt's valve line.
The desirable safety feature of a back seat on the stem is retained while still offering the elimination of a possible body-bonnet leak.
Available NOW in both gate and globe types, ½" thru 2", and in both socket weld and screw ends. These are priced identical to the bolted bonnet GP valves, gate valves the same as Series 12111 and globe valves the same as Series 12141.
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Vogt

Series 2801 Gate Valve
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Series 2821 Globe Valve
Also Available

Both series identical in dimensions and have 13% chrome stainless steel trim.

Vogt GENERAL GP PURPOSE Vogt FORGED STEEL VALVES

HENRY VOGT MACHINE COMPANY, Louisville, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati.

FORGED STEEL

VALVES

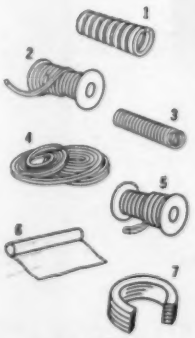
For more data circle 521 on Post Card

A mechanical packing problem...

HOW AN R/M DISTRIBUTOR STOPPED REJECTS AND SHUTDOWNS ON AN AUTOMATIC MOLDING MACHINE

To avoid rejects and shutdowns, a large manufacturer came to R/M for advice on this automatic rotary molding machine. A packing was needed that would control leakage of hydraulic fluid into the mold with resulting shutdown. R/M Vee-Flex® Packing Rings, one of the Big 7 Packing Types, were recommended and proved to be the answer. Since then the machine has been operating daily for 3 years under a pressure of 1000 psi and at approximately 200°F without need of repacking.

The solution to your own packing problems is as handy as your telephone. The R/M distributor near you has a wide range of experience that is yours for the asking. Remember, too, the R/M Big 7 packing family is carefully engineered for your specific job. Write for your distributor's name and address today.



THE BIG 7 PACKING TYPES

R/M's BIG 7 PACKING TYPES MEET 95% OF ALL PACKING NEEDS

R/M

BIG 7 PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings Brake Blocks • Clutch Facings • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

For more data circle 522 on Post Card

154 Indicating Gages — Complete information about company's pointer and indicator gages is contained in a series of product specification sheets. Includes application, construction and operation data. The Hays Corp.

155 For Small Flows — Bulletin 18P describes company's Purge Rotameters for measuring and controlling fluids flowing at low rates. Exploded drawing shows components and design of basic rotameters, and sectional drawings, dimensional and capacity data, and diagram of typical applications. Schutte and Koerting Co.

156 Indicating Flow Meters — This catalog combines all the basic information on company's flow meters, flow switches, and manometers. Covers material composition of components, design characteristics, mounting methods, scales, maximum application temperatures and pressures, direction of flow, pipe connection locations, and other pertinent data necessary for installation and operation of flow meters. Seico Instrument Div., Eclipse Fuel Engineering Co.

157 Photoelectric Control — Bulletin GEA-6822, 16 pp, describes controls for a variety of industrial counting, sorting, signaling, protecting, diverting, detecting, or limiting applications. Included are descriptions, specifications and pricing data on self-contained relay, transistorized relay, high-speed relay, explosion-proof relay, long-distance relay, smoke-density indicator, and other photoelectric devices. General Electric Co.

PROCESSING EQUIPMENT

158 Fluid Processes — Sixteen-pp Bulletin 980 explains Fluidics — the science of fluid processes — and the materials and equipment for handling and processing the liquid and gases used by industry. Covers corrosion engineering, water treatment, ion exchange, reactions, distillation and evaporation, drying and blending, centrifuging, heat transfer, filling, storage, agitation, valving and piping, gas analysis and control, flow rate metering and control, waste treatment, and project engineering. Pfaudler Permutit Inc.

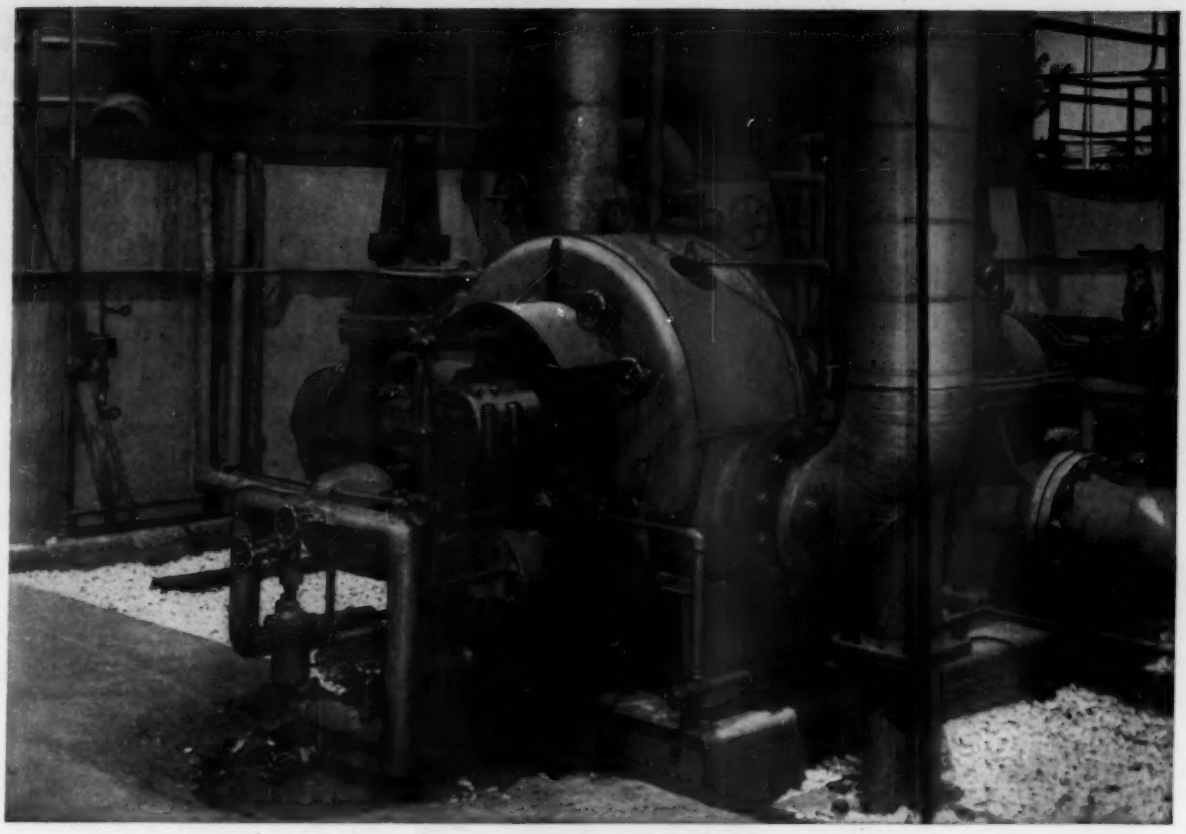
159 Evaporators — Twelve-pp Bulletin YHT 101 illustrates and describes company's evaporators for the production of pure water used in the power, processing, and other industries. Explanatory tables, drawings and photos are included. Yuba Consolidated Industries, Inc.

160 Process Equipment — Illustrated and described in 8-pp Bulletin B-I-F 5–1 are equipment, systems and controls for the process industries. Illustrates and describes meters, instrumentation, feeders, cooling systems, and process equipment. B-I-F Industries, Inc.

OTHER EQUIPMENT

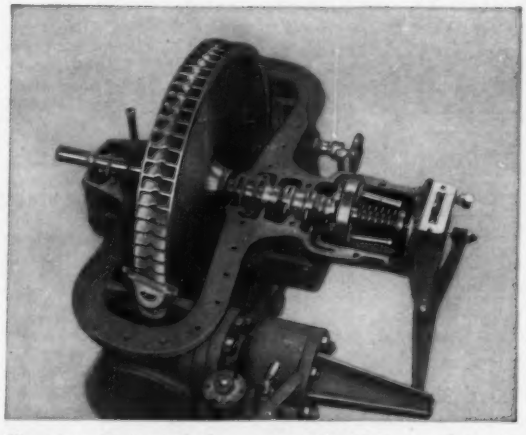
161 Small Demineralizer — Described in Bulletin 595 is a laboratory demineralizer for use wherever small quantities of exceptionally high quality water are required. Features and construction details are described. Betz Laboratories, Inc.

162 Continuous Boiler Blowoff — Possible savings in both labor and operating cost through use of continuous boiler blowoff systems are detailed in 8-pp Publication 5700-A. A simplified method includ-



TERRY SOLID-WHEEL TURBINES

used exclusively at Baton Rouge plant of W.R.Grace & Co.



The upper photograph shows one of the 17 Terry turbines installed at the Baton Rouge, La., GREX high-density polyethylene plant of W. R. Grace & Co. Above, a typical Terry solid-wheel turbine with cover removed to show the wheel construction.

In purchasing equipment for their new 50,000,000-pound high-density polyethylene plant, W. R. Grace & Co. standardized, wherever possible, on a single source of supply for each type of equipment used. Consistent with this policy, Terry steam turbines were used exclusively throughout the utility and process sections of the plant.

A total of 17 turbines were placed in service for driving pumps and fans. These are all of the solid-wheel type, ranging in capacity from 50 to 240 HP.

Terry solid-wheel turbines are known for their long life and sure dependability under the most-trying operating conditions. They feature a single-piece wheel which is virtually indestructible.

Send for details of these trouble-free turbines. Ask for a copy of bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1214

For more data circle 523 on Post Card

ROTO Hand-hole Seat Scraper

Eliminates tedious labor

Assures clean, tight fit

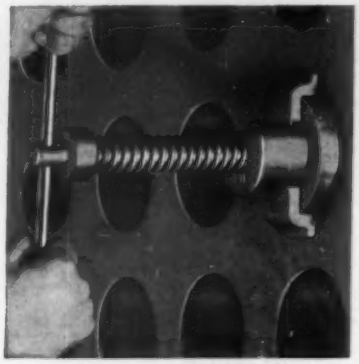
Roto Hand-hole Seat Scraper for B & W Boiler.

Roto Hand-hole Seat Scraper makes short work of cleaning dirty hand-hole seats. This simple, hand-operated tool has adjustable, spring-mounted retractable knives. A few turns to the right remove foreign matter without cutting the metal. A half turn to the left releases the tool, and the job is done. Customers say that the Roto Seat Scraper does the job up to 12 times faster than by any other method. Try one and you'll wonder how you ever got along without it. *Send for details.*

Now available

for most hand-hole shapes and sizes

Standard Roto Seat Scrapers are available for the following equipment. Special types made to order.



Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Type of Boiler	Opening	Tube Size
Babcock & Wilcox # 4	Round	2"
" " " #41	Oval	2"
" " " #70	Round	3"
" " " #48	Oval	3½"
" " " #40	Oval	3¼"
" " " #24	Oval	4"
" " "	Oblong	4"
Bros	Round	3¼"
Casey Hedges	Oval	3½"
" "	Oval	4"
Combustion Eng'rg	Round	3"
" "	Oval	3"
Edgemoor	Oval	4"
Erie City	Ellip	2½"
" "	Oblong	3¼"
" "	Ellip	3¼"
" "	Pear	4"
Foster Wheeler	Oblong	2½"
" "	Oblong	3"
" "	Ellip	4"
Geary	Oblong	4"

Type of Boiler	Opening	Tube Size
Heine	Round	3½"
"	Oval	3½"
International Boiler 2	Oblong	3"
Keeler	Round	3½"
"	Round	4"
"	Diamond	3½"
"	Diamond	4"
Lasker	Oblong	
Murray	Oval	3½"
"	Oblong	4"
Oil City	Oval	3½"
" "	Oblong	4"
Riley Stoker	Ellip	3¼"
Springfield	Ellip	3½"
Union Iron Works	Pear	4"
Henry Vogt	Ellip	3¼"
" "	Oval	4"
Walsh & Weidner	Oval	4"
Wickes	Ellip	2½"
"	Ellip	3¼"
"	Pear	4"
"	Round	4"

ELLIOTT COMPANY – ROTO PLANT

Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

For more data circle 524 on Post Card

ing quick-reference charts for estimating potential heat savings for various blowoff arrangements is given. Cochrane Corp.

163 Fire Fighting Equipment — Illustrated and described in 16-pp Bulletin P-49 are portable fire extinguishers, wheeled units, built-in carbon dioxide extinguishing systems, and fire detection devices. A chart shows which extinguishers are approved for use on each class of fire (ordinary combustibles, flammable liquids, etc.) Walter Kidde & Co., Inc.

164 Fabrication Facilities — Representative machine tools, plants, and engineering and design operations of this manufacturer are illustrated and described in this 32-pp facilities brochure. Emphasizes manufacturing facilities, including fabrication of steam condensers, steam jet vacuum equipment, centrifugal, axial and mixed flow pumps, nuclear components, and similar machinery. C. H. Wheeler Mfg. Co.

Bulletins reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representatives.

165 For Longer Tube Service — Bulletin P-335 describes plastic tube protectors designed to extend the usable life of new and existing condenser and heat exchanger tubes. Protectors come in nylon, polyethylene and phenolic resin. Bulletin shows design features and method of installation. Includes dimensional data. Crane Packing Co.

166 Engineered Equipment — Featured in 16-pp Bulletin YCP858 is a line of engineered equipment for the chemical and petroleum industries, including heat exchangers, towers, pressure vessels, expansion joints, structures, cranes and tanks. Photos of typical installations are included. Yuba Consolidated Industries, Inc.

167 Water, Sewage Treating — Water, sewage and industrial waste treatment equipment is described in 20-pp Book #2617. Contains illustrations and photos of latest sanitary engineering equipment and shows flow diagrams of how it can be installed in typical water, sewage and industrial waste treatment plants. Link-Belt Co.

168 Discharge Drainers — Method of operation and applications of continuous discharge drainers are discussed in Publication 5201-A. Capacities, dimensions, materials and ratings of the complete line of ball-float-actuated rotary valve drainers are included. Cochrane Corp.

169 Fuel Oil Additive — Problems encountered in the storage and use of distillate and residual fuels are described in this fuel oil additive manual. Problems such as sulfur and vanadium corrosion, sludging of fuel oils, and rusting of fuel oil tanks are discussed, and fuel oil additives to overcome these are described. Typical formulations are also given. L. Sonneborn Sons, Inc.

NEW high sensitivity ASHCROFT PNEUMATIC TRANSMITTERS

lower costs...reduce maintenance ...provide tighter control

Ashcroft Non-Indicating Pneumatic Transmitters are made in pressure and temperature types, each in regular and short span. Operation is on low-pressure air: output range, 3-15 psi or 3-27 psi.

These new transmitters are designed around (1) a powerful, efficient relay with sensitivity high enough to operate controllers, and (2) a simple, dual Bourdon tube motion-balance system. High sensitivity permits the use of narrowest proportional band settings on controllers and allows instant controller response to deviations from set point. With a shorter transmission lag, automatic corrective action starts before the deviation becomes critical.

In manual control systems, these new Ashcroft Transmitters (teamed with suitable receivers) make it practical to operate boilers at the most efficient level. In wet processing operations, fractionating columns yield a purer product. Highly suppressed Ashcroft Short Span Transmitters are so sensitive they can "judge" entire control loops and detect any errors in the system.

Basically a 6" cube, lighter than most 8½" pressure gauges, these climate-proof Ashcroft Transmitters are simple to install in cramped locations, are most readily accessible for adjusting or service. Calibration is extremely easy, with linearity checking entirely eliminated. Most parts in all types in the line are interchangeable. Ask your nearby Ashcroft Gauge Distributor about the lower initial costs and other savings that follow when you install Ashcroft Non-Indicating Pneumatic Transmitters. Send for Bulletin 361.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

ASHCROFT PNEUMATIC TRANSMITTERS

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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IT'S *what's behind*
THE BALL THAT COUNTS!

...and Bituminous, too!

BEHIND BITUMINOUS is unlimited supply and ever increasing technology of utilization. *No other usable power source is backed by both these important characteristics.*

You can base your constant power-fuel needs on bituminous with confidence—B&O Bituminous, of course! ***Ask our man!***

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BALTIMORE & OHIO RAILROAD
BITUMINOUS COALS FOR EVERY PURPOSE

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NEW ENGINEERING BOOKS

Convenient Tables and Formulas. 120 pages, 5 by 7 in., paper cover. Published by Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa. Price 50 cents.

Book is filled with convenient tables, formulas and graphical symbols summarizing electrical data, properties of materials, heat transfer and steam information, measurements, and other subjects of interest to design and operating power engineers.

Book was reprinted from the electrical maintenance handbook, Westinghouse Maintenance Hints, because the subjects covered are of a more general and wider interest than to maintenance personnel only. In reprinting this section, Westinghouse has made it possible for other persons to purchase this portion only, instead of the entire Maintenance Hints handbook. Copies may be purchased by writing to the address given above, or from your nearest Westinghouse Apparatus Sale Office.

★ ★ ★

Air Pollution Control, by W. L. Faith. 259 pages, 6 by 9 in. Published by John Wiley & Sons, 440 Fourth Ave, New York 16, N. Y. Price $8.50.

This concise presentation of all the important aspects of air pollution considers its effects, the influence of the weather, methods of measuring air contaminants, applicable control methods, and various legal problems that are related to it.

Book has been written especially for nonspecialists such as civic betterment groups, clean air committees, and other similar organizations. It will be equally useful to technical personnel and management interested in correcting air pollution in industries which are responsible for this contamination.

While not an exhaustive treatise on the subject, it does provide authoritative information, clearly stated in language that can be easily understood. Approach is unbiased with regard to controversial subjects. Special attention is given to the new sorts of air pollution, particularly the relevant problems of automobile exhaust and the radioactivity hazard.

★ ★ ★

Official Register of Industrial Radio Systems. 230 pages, 8½ by 11 in. Paper cover. Published by Communication Engineering Book Co, Monterey, Mass. Price $5.

This comprehensive book is divided into two parts, the first listing all licensees of industrial radio systems in the fields of power utility, petroleum and gas pipeline, special industrials, forest products, relay press and motion picture, and VHF maritime. All pertinent information is given for each stationary and mobile unit of equipment.

More New Books on page 126

how to choose a dependable controlled volume pump

STUDY the specifications of a typical controlled volume pump and you can quickly judge its accuracy . . . corrosion resistance . . . even controllability. But you'll find no specifications for dependability or low maintenance, which may be far *more* important in determining a pump's usefulness.

Over the years Milton Roy has studied thousands of pumps, comparing design and construction with service records, in an attempt to pin down the characteristics that contribute most to dependable pumping. Most of these characteristics demand more time consuming methods of manufacture and more expensive materials than conventional designs. All of them have been incorporated into the standard Milton Roy pumps.

Alignment an absolute necessity

The pump base has more to do with good pump alignment than any other single part, yet its importance is rarely recognized by the pump buyer. Dependable pumping demands an extremely rigid and sturdy webbed base that positively resists deformation and prevents the misalignment that is sure to result. Base pads should be machined to eliminate the problems of aligning and protecting rough cast parts.

Massive pump frames are another necessary bulwark against distortion. Just as rigid bases keep motor, drive, and pump aligned, heavy pump frames keep plunger, packing, and liquid end in line. As a result, both packing and plunger wear more evenly and give longer service.

"Over-Engineering" assures longer life

Typical examples of how dependability must be built into a pump are the crank nuts. Conventional hardware often permits slight crank slippage . . . just enough to throw an undesirable strain on the pump drive. Substituting more expensive brass nuts boosts costs, but, since they can be drawn up tighter, eliminates the problem of slippage.

Other examples of "over-engineering" that extend pump life include generous bearing surfaces that far exceed permissible minimums . . . self lubricating connecting rod bearings . . . special gear tolerances that eliminate grinding wear, vibration, and noise . . . and high cross head length to diameter ratios to absorb unavoidable abuse without injury. Furthermore, the surface of the pump must be protected with a resistant coating as protection against corrosive fume and splash.

These three Milton Roy pumps have been feeding phosphate solution to the boilers of a major East Coast brewer for twelve uninterrupted years. Aside from periodic lubrication and examination, the total cost of parts replaced in that time is just $18.00 . . . twelve sets of packing.

The low cost of dependability

Obviously, a pump with features like these has to carry a higher price tag than one without. But the *cost* of dependable pumping is something else again. As the caption above illustrates, savings gained through years of dependable pumping with minimum maintenance expense far outweigh any slightly higher initial cost. There's little doubt that the more dependable pump always costs less in the long run.

If accurate precision metering of liquids is one of your problems, look again to the enviable reputation more than 75,000 Milton Roy pumps have established for dependable controlled volume pumping.

Milton Roy Company, 1300 East Mermaid Lane, Phila. 18, Pa.

milton Roy
CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • pH Instruments

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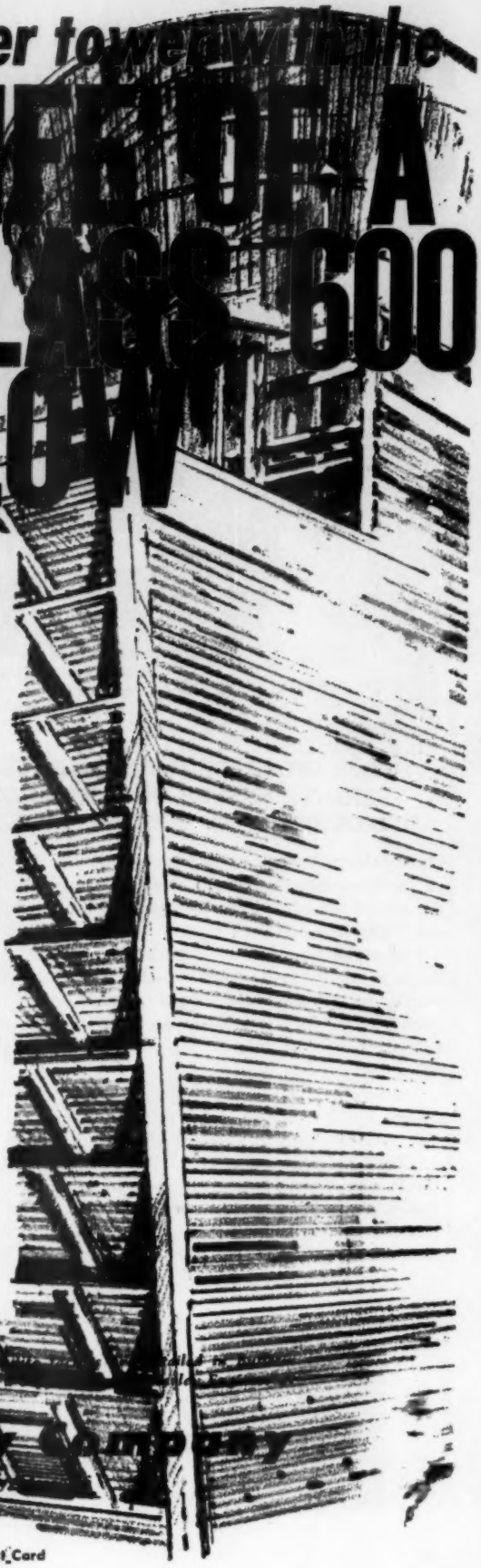

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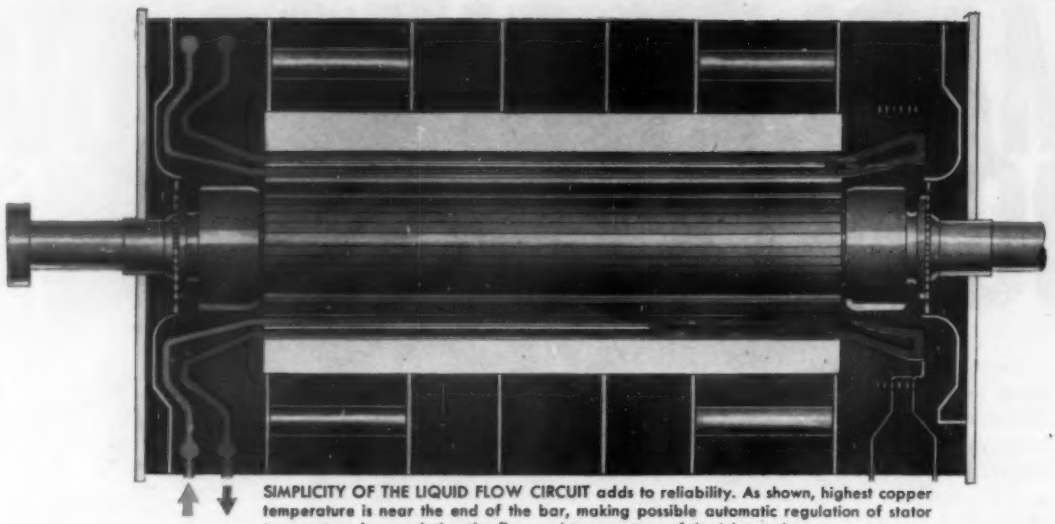

SIMPLICITY OF THE LIQUID FLOW CIRCUIT adds to reliability. As shown, highest copper temperature is near the end of the bar, making possible automatic regulation of stator temperature by regulating the flow and temperature of the inlet coolant.

HELPS INCREASE PERFORMANCE... PERMITS HIGHER UNIT RATINGS ...REMOVES UP TO 16 TIMES MORE HEAT

One of the most significant and successful developments in the manufacture of large steam turbine-generators is the use of liquid coolant in hollow stator windings by the General Electric Company.

Use of the liquid coolant permits smaller frame sizes, since it removes the heat directly from the copper so that up to 16 times more heat may be removed than was possible by former methods. This means improved performance and better utilization of materials, with resultant savings.

In developing the hollow stator bars not only did operating conditions have to be considered but the method of fabrication also had to be reckoned with.

The selection of copper as the metal to be used was virtually a must as the principal purpose of the metal was that it possess maximum electrical and thermal conductivity. But what kind of copper and in what shape was something else.

General Electric engineers, having worked with Revere in the development of hydrogen-cooled rotor bars that permit doubling generator rotor output without increasing the physical size, again called on Revere.

Revere's Technical Advisory Service and its Methods Department cooperated with General Electric engineers. Numerous discussions were held regarding the sizes, tolerances, and temper of the copper which would be most suitable. One of the chief concerns was producing the close tolerances required, on a production basis.

The result was a series of Revere rectangular drawn copper tubes arranged in two tiers to form the stator bars; cross-section of which you see at upper right. The dielectric construction of this liquid-cooled bar is as simple as the conventional bar.

Evidence of the performance of Revere drawn copper tube as liquid-cooled stator bars is the fact that General Electric, since adopting this material, has increased its use to almost a thousand miles.

This is another example of Revere helping "fit the metal to the job," thus saving money while producing a more efficient product. Why don't *you* call on Revere to help with your "important ones?"

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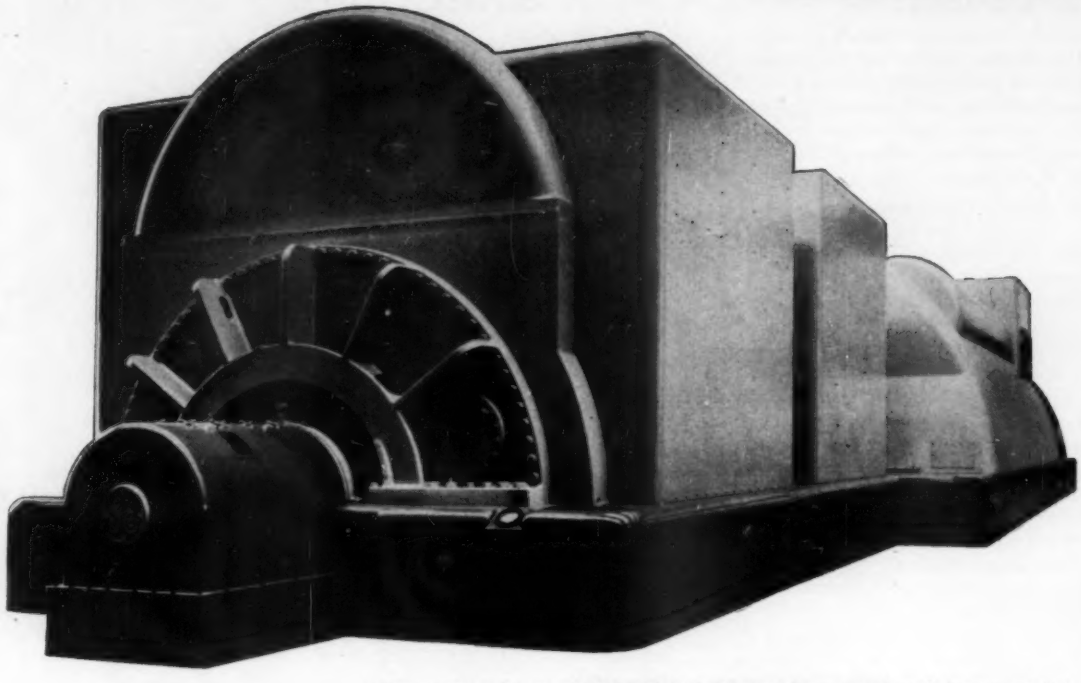
used as liquid-cooled stator windings in large conductor-cooled generator



GENERAL ELECTRIC CONDUCTOR-COOLED GENERATOR with liquid-cooled stator installed in Linden Generating Station, Public Service Electric and Gas Company, New Jersey

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Now's the time to prevent freezing of heater coils... with Production Planned steam trapping

By John W. Ritter, Test Engineer, SARCO Company, Inc.

Freezing of heating coils usually takes place when outside air temperature is slightly below the freezing point, and it is most common in coils that have the steam supply controlled by a temperature regulator which keeps the outlet air temperature constant. Freezing can occur only when the coil becomes water-logged, and in this case the steam trap is often blamed for the trouble.

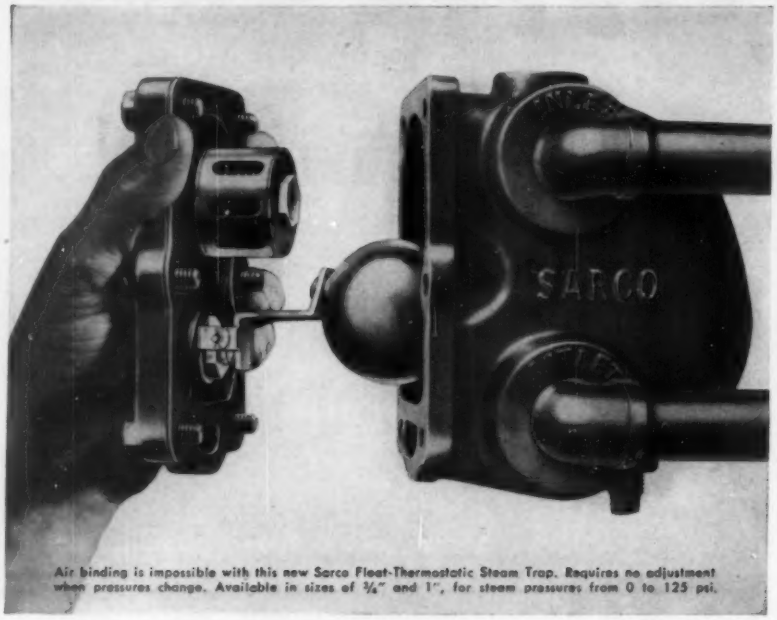
The discharge capacity of any steam trap depends upon the difference in pressure between the trap inlet and its outlet. If there is no pressure difference, the trap cannot remove condensate; and if inlet pressure is lower than outlet pressure, condensate will be held back in the coil.

There are three ways to avoid this difficulty. First, a pressure controlled bypass can be arranged around the temperature control valve to prevent heater pressure from falling below a preset minimum. This plan would make the temperature controller ineffective over part of the range of outside air temperature.

A better solution is to install the steam trap well below the unit, and thus provide a hydraulic leg to enable the trap to discharge even with a vacuum in the steam space. An ample sized vacuum breaker should be installed at the top of the steam inlet of the heater.

To compute the hydraulic head needed, use a figure of 3′ per 1 psi pressure differential. For example, if the trap has the required capacity at 1 psi differential, the minimum head will be 3′.

Thirdly, on new construction, the preheater can be divided into two sections. The first should be capable of raising the air to at least 32° under minimum outside air conditions. The second section should raise the air from 32° to the final temperature. Full steam is supplied to the first coil at all times, while the second is controlled to maintain the final temperature needed. The first coil will not freeze because of the maintained pressure, nor will the second, because minimum air temperature is always above 32°.



Air binding is impossible with this new Sarco Float-Thermostatic Steam Trap. Requires no adjustment when pressures change. Available in sizes of ¾" and 1", for steam pressures from 0 to 125 psi.

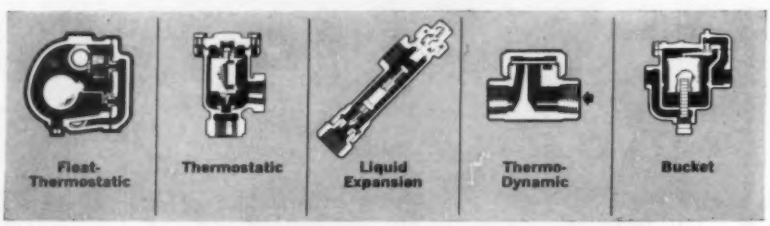
A SARCO F-T Steam Trap will drain condensate completely

Count on the Sarco Float-Thermostatic Steam Trap to discharge condensate practically at steam temperature, continuously and without shock. Sarco F-T's do not cause pressure fluctuation while discharging.

For *production planned* trapping of heating coils, with accurate temperature control, use the new Sarco Steam Trap Type F-T.

Write for Technical Bulletin T502 on prevention of freezing in heater coils. You'll also receive a bulletin on Sarco F-T Steam Traps.

Remember that Sarco can give you *impartial* advice on steam trapping because only Sarco makes all 5 types. 5968-B



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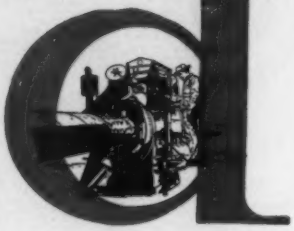

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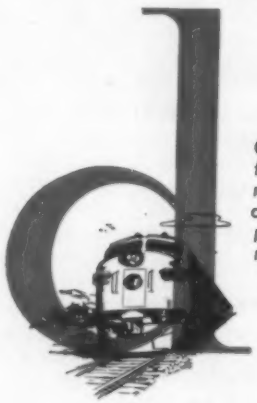

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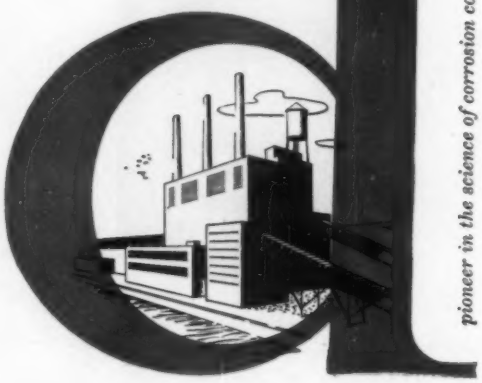

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Power Engineering

ATOMICS

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A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World Published by Technical Publishing Co.

September 1959

Reactor Safety. Some weeks ago, shortly before the first nuclear-propelled merchant vessel was launched at the New York Shipbuilding Corporation at Camden, the possibility of this ship passing through the St. Lawrence Seaway into the Great Lakes was discussed in newspaper articles. There was some question, it seemed, whether the Savannah's broad beam would permit her to pass through the narrowest portions of the seaway.

There are, of course, no plans to have the Savannah enter the Great Lakes; the purpose of this first nuclear-powered ship is to demonstrate to nations all over the world that this ship is safe and that her entry into foreign ports involves no hazards. However, what was of considerable interest in the newspaper articles was not so much the discussion of the ship's physical size in relation to the canals but the report that certain Great Lakes interests were endeavoring to institute measures which would prevent the ship from coming down the St. Lawrence Seaway, because of the hazard her presence would create.

This attitude on the part of those who have little or no background in the field of nuclear technology is typical; instinctively, they associate anything about atomic energy with danger—danger from explosions, danger from radioactivity. Last summer (1958), when the Nautilus and the Skate were in European waters, certain European ports refused the entry of these submarines into crowded harbors such as that at Copenhagen. There was good reason for this in this particular case because the port authorities had no technical data regarding the power plants of the submarines on which to judge the degree of hazard they introduced. The submarines are naval weapons and as such, all important details of their design and construction remain classified.

The case of the Savannah is entirely different. Being a commercial ship, built for peaceful use, all aspects of her design, construction, and operation are available. There is nothing of a secret nature about any of the nuclear or mechanical features of this ship because the U. S. Government's entire purpose in building this ship is to demonstrate to the world that nuclear-powered commercial ships are just as safe as any conventional vessel; indeed, because of the effort expended in making this ship safe and in selecting her crew, the chances are that the Savannah constitutes somewhat less of a hazard than a conventional ship.

The TRIGA FLASH. There is, of course, no question concerning the inherent danger in a nuclear reactor which is not properly controlled. As indicated in a previous article in ATOMICS, a nuclear reactor contains all the fuel it may use over a period of years, and since nuclear reactions take place with extreme rapidity, an uncontrolled reactor would constitute a great hazard. At the same time, if the proper controls are used, particularly those which make a reactor self-regulating, the danger is very much reduced.

As an example, last June, at General Atomic's John Jay Hopkins Labora-

tory at San Diego, the TRIGA research reactor installed there was "flashed" to a peak power level of 1,500,000 kilowatts! In this test the TRIGA prototype reactor increased its power output from 1 watt to 1,500,000 kilowatts (thermal) in less than one-tenth of a second. The actual flash lasted approximately 15-thousandths of a second. Scientific personnel could safely stay within a few feet of the top of the tank during the flash. Following the peak, the self-regulating feature of the TRIGA reactor's unique fuel-moderator elements of uranium-zirconium hydride immediately reduced the power to normal operating levels.

This peak flash of a million-and-a-half kilowatts is a new record for the energy level attained by any nuclear reactor in controlled operation, exceeding a previous recorded high of 530,000 kilowatts, achieved by the AEC's kinetic experiment on water boilers (KEWB) in a test conducted in April, 1958. To have produced a similar burst of instantaneous energy by electrical means would have taken the entire generating capacity serving the city of San Diego. During the test, the central temperature of the reactor core, which contained 300 pounds of metal, was raised from room temperature to 1100 degrees F within a tenth of a second. The energy released went directly into raising the temperature of the fuel materials, and, only much later, was this heat transmitted into the water in the reactor core. Thus, the water remained in the reactor throughout the test without boiling or being expelled from the core. The TRIGA flash also provided the highest intensity of neutrons available for radiation studies ever attained under controlled conditions in a nuclear reactor. At 1,500,000 kw, the reactor provided a neutron flux level of approximately 5×10^{16} neutrons per sq cm per sec.

Basic Approaches in Hazard Control. The TRIGA flash is described here to show what can be done in the design of a reactor to reduce hazards; ordinarily, a power reactor would not be subjected to such rapid power rise.

The potential danger of a nuclear reactor to off-site personnel and property stems from the very large quantity of radioactive material which builds up in most reactor systems. As a rough rule of thumb, it may be said that the fission-product radioactivity content (beta plus gamma) of a reactor very shortly after shutdown is of the order of 10 curies per thermal watt of reactor power.

For operating times of a few hours or more, the activity level immediately after shutdown is not very sensitive to the duration of operation, but the rate of decay of activity is sensitive to this variable. For reactors which have operated for a long time, the rate of decay is slow. In a reactor which has operated for a year, a year of shutdown will reduce the activity less than a factor of 100 below that shortly after shutdown.

When one considers that the tolerance inside the human body for many fission products is measured in microcuries, the potential hazard from fission products, if they could escape and become dispersed, is very large. An analysis of the possible effects of large-scale fission product release led to the conclusion that if half the total fission products were released from a reactor of 500-kw heat output, located in what might be an average location, about 30 miles from a major city, the total number of deaths might range from 0 to 3400, the number of injuries from 0 to 43,000, and property damage from one-half million dollars to seven billion dollars! And, a 500-kw thermal reactor is very small compared to power units ranging from 250,000 to 700,000 kw, thermal.

This potentiality of the reactor for widespread damage, if uncontrolled dispersion of fission products could occur, has required a very conservative approach to the question of reactor hazards. From the earliest days of reactor design, it was realized that every reasonable precaution should be taken to prevent accidents which might allow the escape of fission products from the reactor envelope. As soon as the problem of locating reactors in populated areas presented itself, a further precaution was adopted, which consisted of enclosing the reactor and much of the associated equipment in a secondary containment shell. The containment shell was provided for the sole purpose of preventing widespread destruction and damage in case of an accident of high destructive potential, despite the low probability of such an occurrence.

It cannot be assumed, however, that even a steel containment vessel would remain intact under unforeseeable conditions, despite the care taken in constructing and testing such vessels. For this reason, location must always be considered, and it seems sensible to put the powerful testing reactors as far removed as possible from populations and to use such reactors for hazardous experiments.

Remote location is not always possible in the case of nuclear power reactors, but power reactors are operated at safer levels. The cost of safety and secondary containment is a subject of concern among all reactor designers. Recently, Siddall* has questioned the large expenditures made for these purposes in the field of nuclear energy and has proposed new approaches to the question of reactor safety. He considers nuclear plants from two aspects, the humanitarian and the economic, and points out that both of these considerations would place a limit on the amount which should be expended in achieving safety of nuclear plants. From the humanitarian point of view, Siddall postulates that the optimum degree of emphasis on reactor safety is that which results in the maximum life span for the average population. To the extent that nuclear plants have accidents which result in death or injury, they tend to decrease the average life span. To the extent that their output replaces that of other dangerous industries (e.g. the coal industry), they may effectively increase the life span, and to the extent that they increase the general prosperity of the nation, they may also increase the average life span through better housing, better nutrition, better hygiene, etc. Siddall anticipates that the net effect of nuclear plants will be to increase the life span; in the early stages this increase would result entirely from the greater safety of the nuclear industry in comparison to the coal industry. The humanitarian approach would be to find an optimum degree of emphasis to put on reactor safety, which would maximize this net increase in life span.

The economic aspect of the problem appears straightforward in principle: The optimum degree of safety is that which minimizes the combined expenses of safety precautions and of damages from reactor accidents over a long period of time. Siddall estimates that the economic optimization requires somewhat higher safety standards than the humanitarian optimization but that our present preoccupation with safety is far greater than can be justified on either basis.

Siddall's thesis constitutes a logical approach to the abstract consideration of reactor safety, and no doubt it will color the thinking of many who are concerned with reactor safety.

In the United States the most obvious feature of safety practice is the widespread use of the secondary containment vessel. To a large extent this characteristic stems from the types of reactors used, yet it probably reflects also a special degree of concern with reactor safety. The necessity for the secondary containment shell is often deplored as an economic penalty on the nuclear plant, and from time to time it has been suggested that the money invested in such containment might be spent more effectively in other ways to attain safety. But no other safety concept has yet been devised which is so nearly independent of all other safety-devices and features, and which therefore can give a comparable degree of safeguard against systematic errors in the safety analysis.

The British gas-cooled natural uranium reactors, in contrast to the water-cooled types used in the U.S., are large in size and operate at low power densities and specific powers. They are not provided with secondary containment structures, and it is questionable whether such structures for these reactors would be economically practical. The excess reactivity of the British reactors is normally low and cannot be made very large so long as natural uranium is used as fuel. These reactors have slow start-up rates—6 to 7 hr—and these slow rates of start-up are tolerable because shutdowns are rare, the nuclear plants being used for base load generation, and later plants are being designed for reloading during operation.

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*Ernest Siddall; Statistical Analysis of Reactor Safety Standards, Nucleonics, 17(2): 64 February 1959. See also, Power Reactor Technology Quarterly Technical Progress Report, Vol. 2 No. 3, June 1959, available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C., at 55 cents.

They are also characterized by relatively strong "prompt" negative temperature coefficients of reactivity due to the Doppler broadening of U-238 absorption resonances.

Reactor Fuses. For a number of years, schemes have been considered for the prevention of reactivity accidents through the use of nuclear fuses—elements of some type which would be installed as part of the reactor and which would have the characteristic of producing a large decrease in reactivity whenever the power level exceeded some predetermined safe value.

For low-power training reactors, in which the normal operating power is far below the dangerous level, the development of a fuse is relatively straightforward. In high power research and in testing reactors and power reactors, the normal operating power is not far below that which will damage the fuel elements by overheating. In such cases the setting of the fuse trigger must be quite precise, and the precision must be attained despite any changes in power and neutron flux distributions which may occur during the life of the reactor.

Several types of reactor fuses have been tried out. The first transient tests were made on fuses constructed by General Electric Co and J. T. Weills of Argonne National Laboratory, with the BORAX-I reactor, in 1954. The Argonne fuse consisted of a cadmium cylindrical shell, spring-propelled into a reactor core when a solder restraining link was melted by the heating of a uranium strip. The fuse was found to be easy to use and limited the power excursions of the reactor, which were made at periods as short as about 25 milliseconds. The components of this fuse were a pressure chamber filled with helium, a tube containing powdered normal boron, a fusible disk containing U-235, and a partially evacuated boron receiver chamber that surrounded a specially-constructed fuel assembly. The fusible disk was ruptured by nuclear heating, allowing the compressed helium to force the powdered boron into the 1/16-in. annular space surrounding the fuel assembly.

More recently, Atomics International has been carrying on development work on fuses of various types for the AEC, and fuses for research reactors, power reactors, and for the Hanford production reactors have been under development. One of the most important components of a reactor fuse is the triggering mechanism. For this reason General Electric conducted fuse trigger tests at the SPERT facility to explore the possible development of a more sensitive, faster-acting trigger primarily for detonating cartridges containing gunpowder as the propelling element. This type of trigger was found to be much faster than the fusible disk but requires some design changes to keep it from acting, when the ambient temperature changes, without sacrificing its ability to limit a slow runaway of the reactor.

The development of an absolutely reliable reactor fuse is a most desirable objective in reactor technology, one, which if achieved, might well result in the eventual elimination of secondary containment structures.

Andrew C. Kramer

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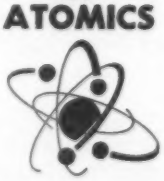

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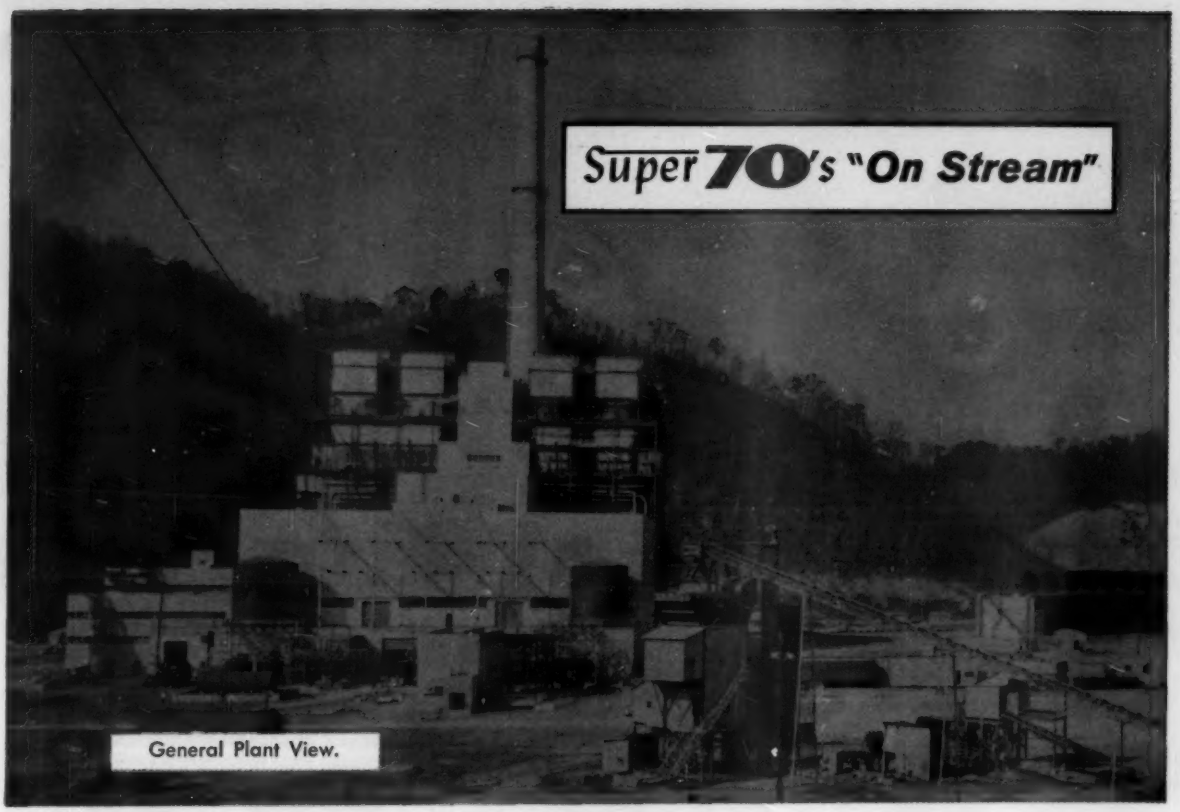
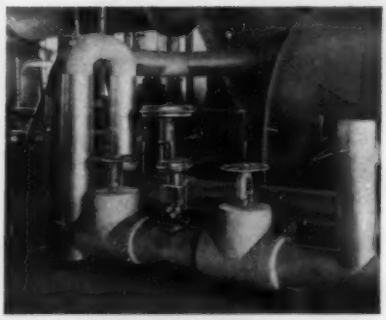
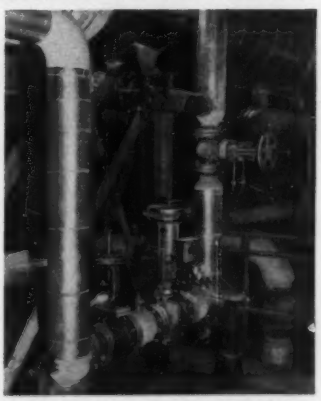


General Plant View.

Clinch River Plant, Units 1 & 2


High Pressure Heater Drain To Deaerator.


Number 4 Heater Level Control Valve.

Highlighting the vast power expansion program of the American Electric Power System, two additional 225,000 KW steam-electric generating stations were recently put on the line by the Appalachian Power Company.

In these fully automatic reheat stations, BS&B Super 70 Control Valves, together with BS&B Liquid Level, Pressure and Temperature Controllers, are employed in heater drain and other auxiliary control systems.

Engineering service, including preliminary engineering studies, multi-load analysis and start-up assistance were provided with BS&B Controls in the Clinch River Plant to assure unit responsibility as well as efficient and dependable system performance.

In the two world's-largest forthcoming 450,000 KW super-critical once-through stations, BS&B Controls will again render proud service to the Power Industry through the American Electric Power System.

BLACK, SIVALLS & BRYSON, INC.
Controls Division, Dept. 1-R9
7500 East 12th Street • Kansas City 26, Missouri

SUPER BS&B 70

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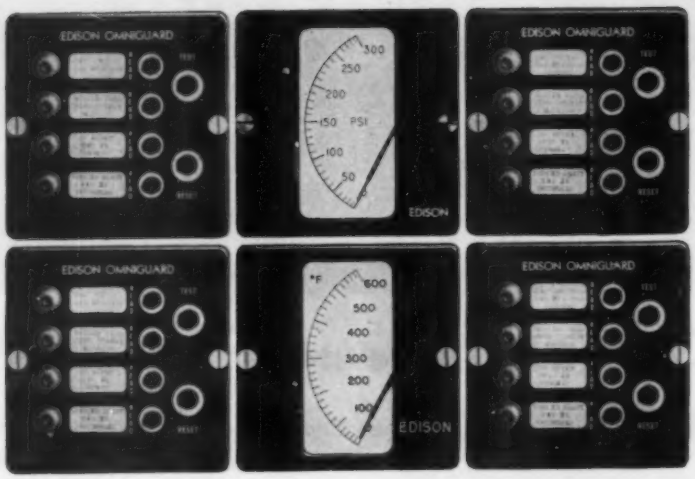

EDISON OMNIGUARD
300
250
200
150 PSI
100
50
EDISON
EDISON OMNIGUARD
EDISON OMNIGUARD
°F
600
500
400
300
200
100
EDISON
EDISON OMNIGUARD

GUARD ALL CRITICAL PRESSURES AND TEMPERATURES WITH . . .

THOMAS A. EDISON LOW-COST, OMNIGUARD WARNING SYSTEM

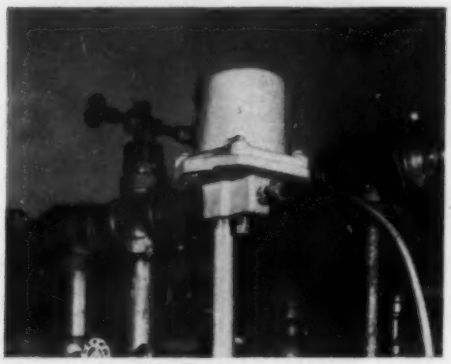
Here is a versatile, highly-reliable continuous warning and monitoring system. By simply pushing a button on this panel you obtain a reading of *key pressure* and *temperature* points throughout your plant. In addition, this system provides instantaneous warning when pressure or temperature deviates from pre-set limits.

PRESSURE With the Edison Omniguard system you can monitor gas, fluid or vapor pressure. Heart of the system is a rugged accurate pressure detector which converts pressure directly to electrical resistance—requires no milli-volt conversion—no amplifier. For pressures under 60 PSI a precision capsule is the sensing element. From 60 to 3000 PSI special burdon tube elements are used.

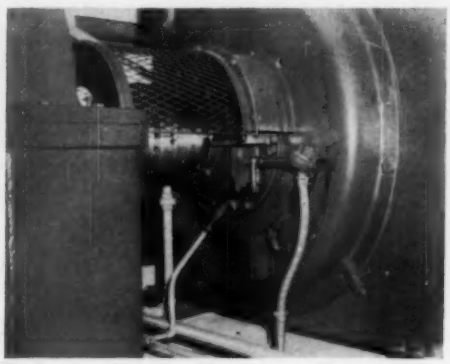
When pressure changes, resistance varies and this deviation is transmitted to the control panel. Units operate over ambient temperatures of 32° to 150°F. Control panels are available with a wide variety of scales and are equipped with both normally open and normally closed alarm contacts to operate any type of auxiliary device or to automatically shut down machinery or process.

TEMPERATURE Edison Omniguard also provides reliable protection from overheating. You can monitor the temperature of bearings, gases and liquids in critical equipments or processes. Reliable Edison Resistance Temperature Detectors have no moving parts and give instantaneous warning when limits are exceeded. Unlike other systems which only scan, Omniguard is continuously monitoring. You can obtain exact readings of temperatures in all parts of your plant from one central control panel.

For greater flexibility and reliability each detector circuit is completely independent. If one circuit is damaged, all other circuits remain "on guard." When changes or additions are required they can be accomplished quickly and easily.



Compact, reliable Resistance Pressure Detector transmits changes in pressure to central control panel.



Rugged, accurate Resistance Temperature Detector guards against overheating of this motor bearing.

Thomas A. Edison Industries
INSTRUMENT DIVISION
37 LAKESIDE AVENUE, WEST ORANGE, N. J.

McGRAW EDISON

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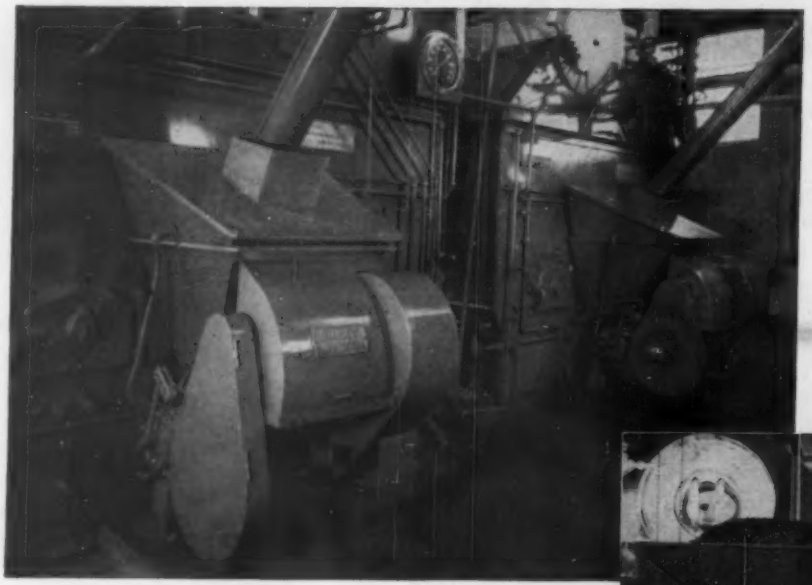
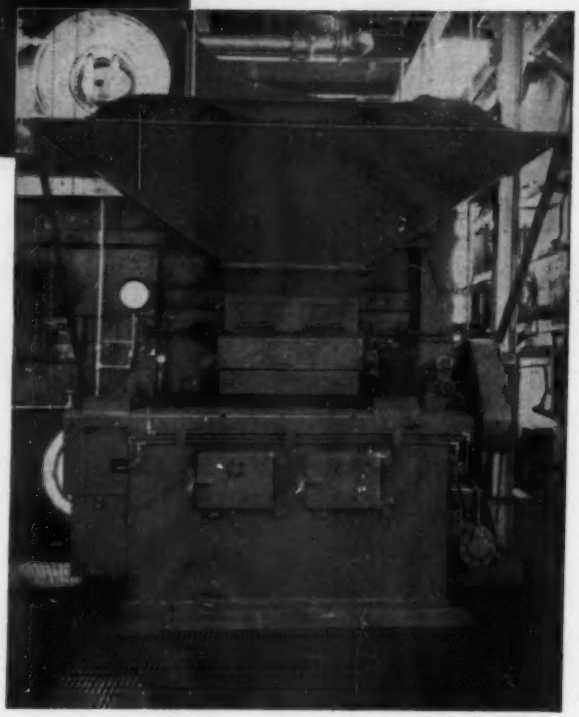
Does Your Package* Include

DETROIT STOKER ECONOMY?

***Package Boilers, of Course**



Detroit LoStokers firing two Wickes Package Boilers, Type A.O. continuous rating—6000 pounds steam per hour.



As the installation convenience of the package boiler is more and more widely appreciated, the question often is asked "Why can't we have the advantages of a package boiler with the economy of efficient coal firing?"

The answer is—you can. Water tube package boilers designed for stoker firing are readily available.

And a *Detroit* Stoker gets the most economy out of coal, the most economical fuel. This economy plus the exceptional dependability and low maintenance of Detroit Stokers assures you steam at the lowest cost.

The Detroit Stoker line includes a number of types specially adapted to package boilers.

DETROIT STOKERS COST LESS . . . COST EQUALS INITIAL INVESTMENT PLUS UPKEEP PLUS PRODUCTION LOSSES DUE TO EQUIPMENT OUTAGE. THE TOTAL IS LESS WITH DETROIT.

Ask for details on Detroit Stokers with package or other boilers.

Detroit RotoStoker "CC"—continuous cleaning, Firing Springfield high pressure Package Boiler. Continuous rating—35000 pounds steam per hour. One of five furnished one customer.

DETROIT STOKER COMPANY

MAIN OFFICE AND WORKS • MONROE, MICHIGAN

District Offices or Representatives in Principal Cities

8108

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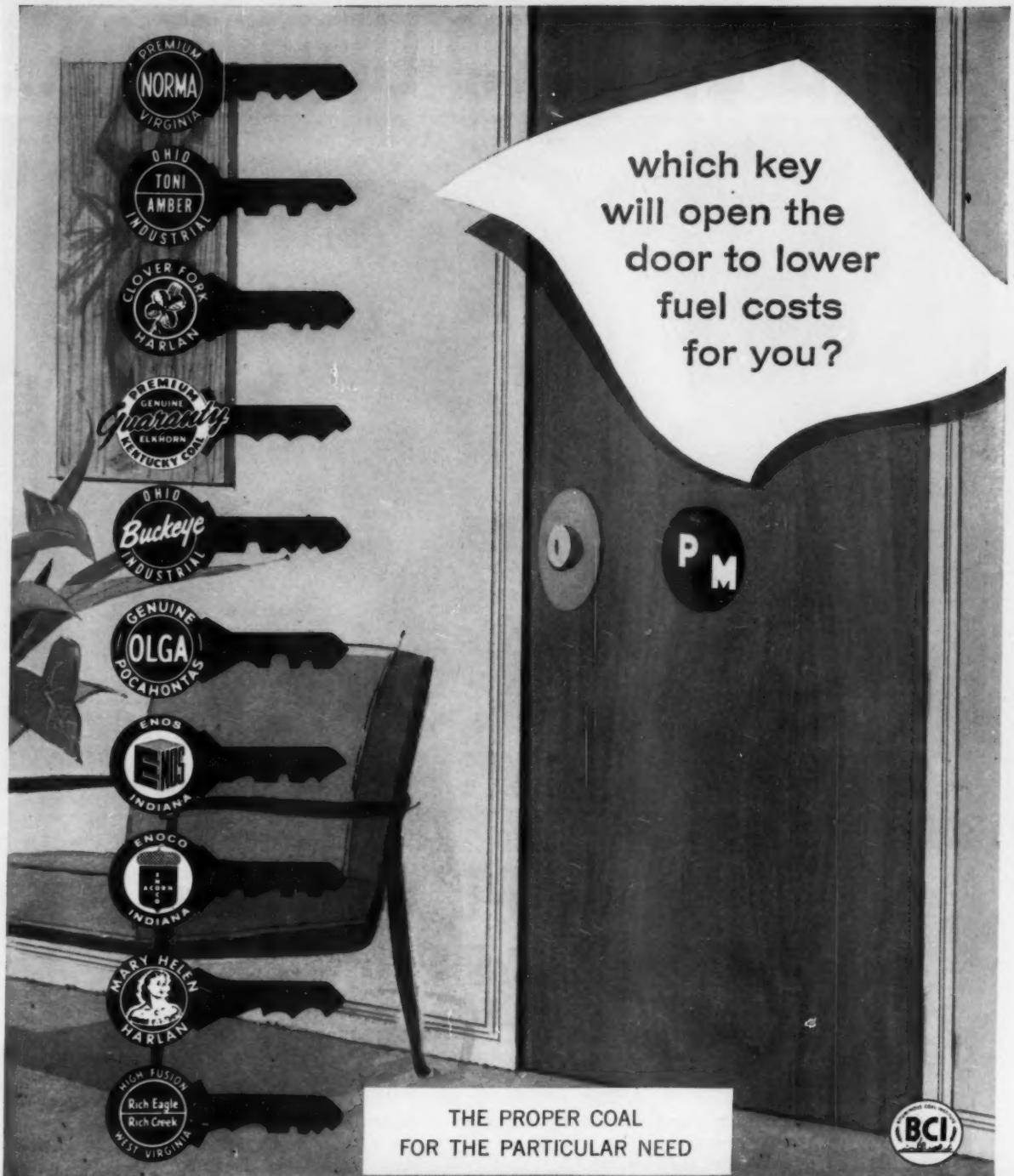

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CHICAGO • CINCINNATI • DETROIT • DULUTH • [illegible] • GREENSBURG
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exclusive T-BLOCK design doubles life of piston rings on JOY oil-free compressors

All Joy oil-free compressors are equipped with carbon-graphite piston rings of T-block design. They require no lubrication and compensate automatically for wear. Blow-by is virtually eliminated for the life of the ring. Brass expanders and stainless steel springs operating in teflon sleeves provide the piston rings with controlled pressure evenly distributed on the cylinder walls. Result: "bug-free" operation and freedom from corrosion. Compressor owners report ring life of 8000 operating hours, and more.

If your operations require oil-free compressed air, whether for instrumentation or for processing, get complete details from Joy. A complete line of oil-free compressors is available from 95 to 3600 cfm, 15 to 600 hp.

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RESISTS FIRE, WATER and CHEMICALS

There's a specialized Foster system of rugged coatings, sealers, and adhesives developed to meet your toughest problem of thermal-insulation protection. Insure your insulation investment throughout your plant—see your Foster Sales Engineer, or outline your conditions in a card or letter.

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SOLD BY AMERICA'S LEADING INSULATION DISTRIBUTORS AND CONTRACTORS

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standard products for thermal insulation protection

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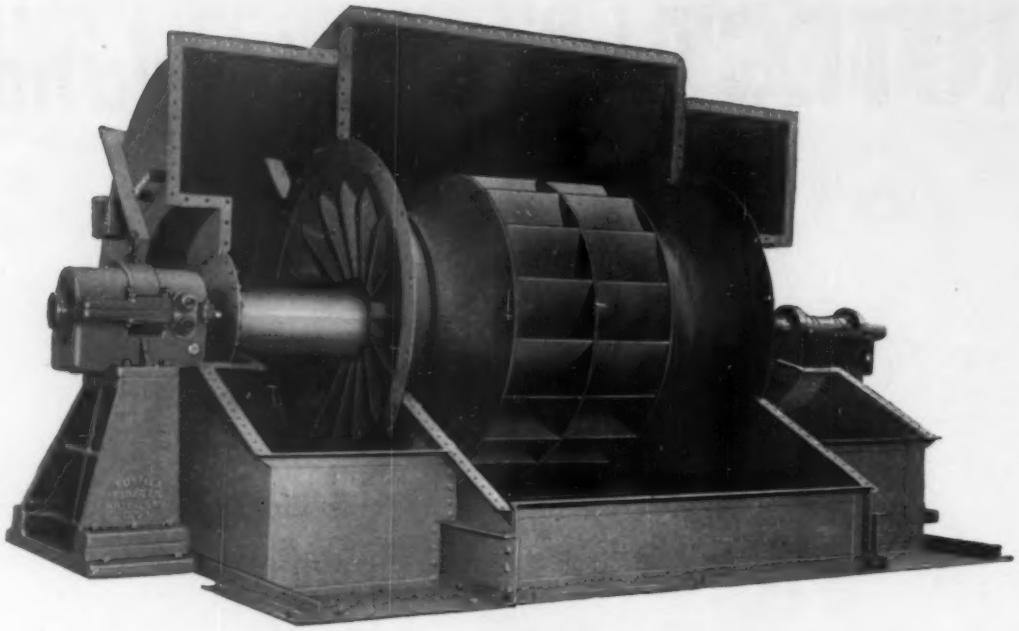

"Buffalo" Airfoils are Available in Capacities in Excess of One-Half Million CFM, Pressures to 80" Water.

"BUFFALO" AIRFOILS COST LESS TO OPERATE ...REQUIRE LESS MAINTENANCE

HERE'S WHY: If you are considering the use of airfoil fans for mechanical draft service, ponder these facts regarding the "Buffalo" Airfoil.

With an extremely broad static efficiency curve, as compared to most competitive airfoil designs, the "Buffalo" Airfoil definitely costs less to operate. Major factors governing this efficiency are—a completely streamlined inlet with inlet bell and wheel flange forming a true half-circle —fixed or variable inlet vanes, where used, are placed well into the inlet throat to fully utilize horsepower reducing spin developed by the vanes — generous inlet boxes with external bracing give low entry loss — airfoil wheel incorporates proper blade passages for best air-flow through the wheel—scroll shape lets air stream from blade passages to housing channel with greatest ease — divergent outlet provides optimum static regain from cut-off.

This top efficiency, combined with the famous "Buffalo" "Q" Factor* Construction for a longer life with less maintenance, makes the "Buffalo" Airfoil best suited for this specialized service. For full details phone your Buffalo Engineering representative or write for Bulletin FD-905.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

"Buffalo"

BUFFALO FORGE COMPANY
Buffalo, N. Y.

Buffalo Pumps Division Buffalo, N. Y.
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

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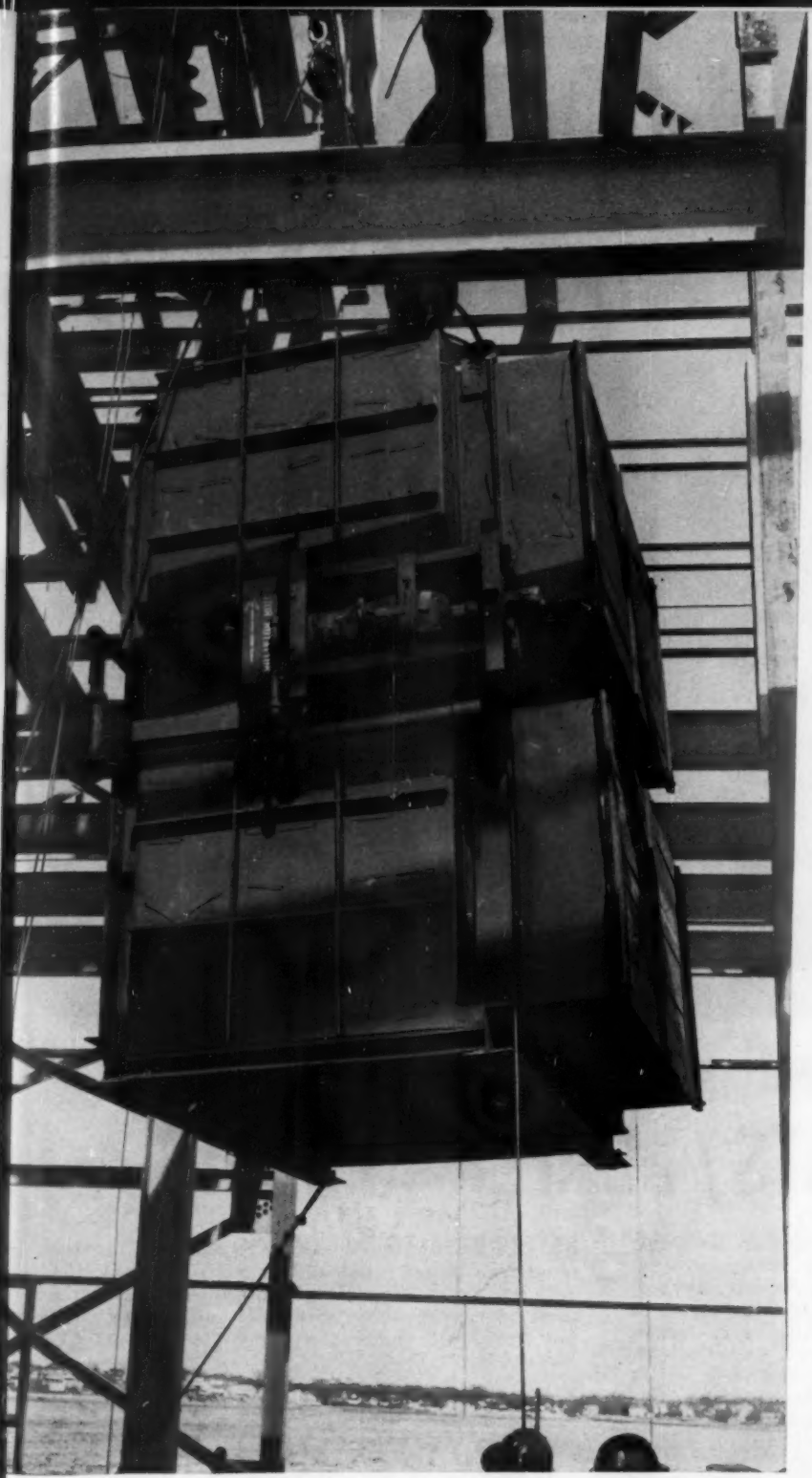

Complete and ready to run, Package Air Preheater is lowered through steelwork of new power station at Braintree, Mass. Installation at Braintree Electric Light Dept. uses largest available package preheater, with a diameter of approximately 12'. Fitted to a 130,000 lb per hr boiler, this Package Air Preheater will boost combustion air temperature by about 420°F with heat recovered from stack gas.

PACKAGE AIR PREHEATER

gives twofold economy at Braintree's new power station

PACKAGE DESIGN FACILITATES INSTALLATION; FUEL SAVINGS TO WRITE OFF COST IN 2 YEARS.

Braintree, Mass., has achieved an economic double-header with the Air Preheater in their new power station:

1. Initial saving: The Package Air Preheater, shown above, was delivered as a completely preassembled unit. All it needs is gas ducts and a power line and it's ready to work—installed at a fraction of the time and cost required for conventional units.

2. Long-term savings: Records prove that Braintree's Package Air Preheater can pay for itself—just on fuel savings alone—within two years.

Package design gives you these advantages on boilers as small as 25,000 pounds of steam per hour —or as large as 250,000 lbs per hr. And a Package Air Preheater is one of the surest ways to reduce fuel consumption: you cut your fuel bill 1% with every 45-50°F increase in preheated air temperature.

Get all the facts. Write today for your copy of the free 14-page booklet describing the multiple savings you get with a Package Air Preheater.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

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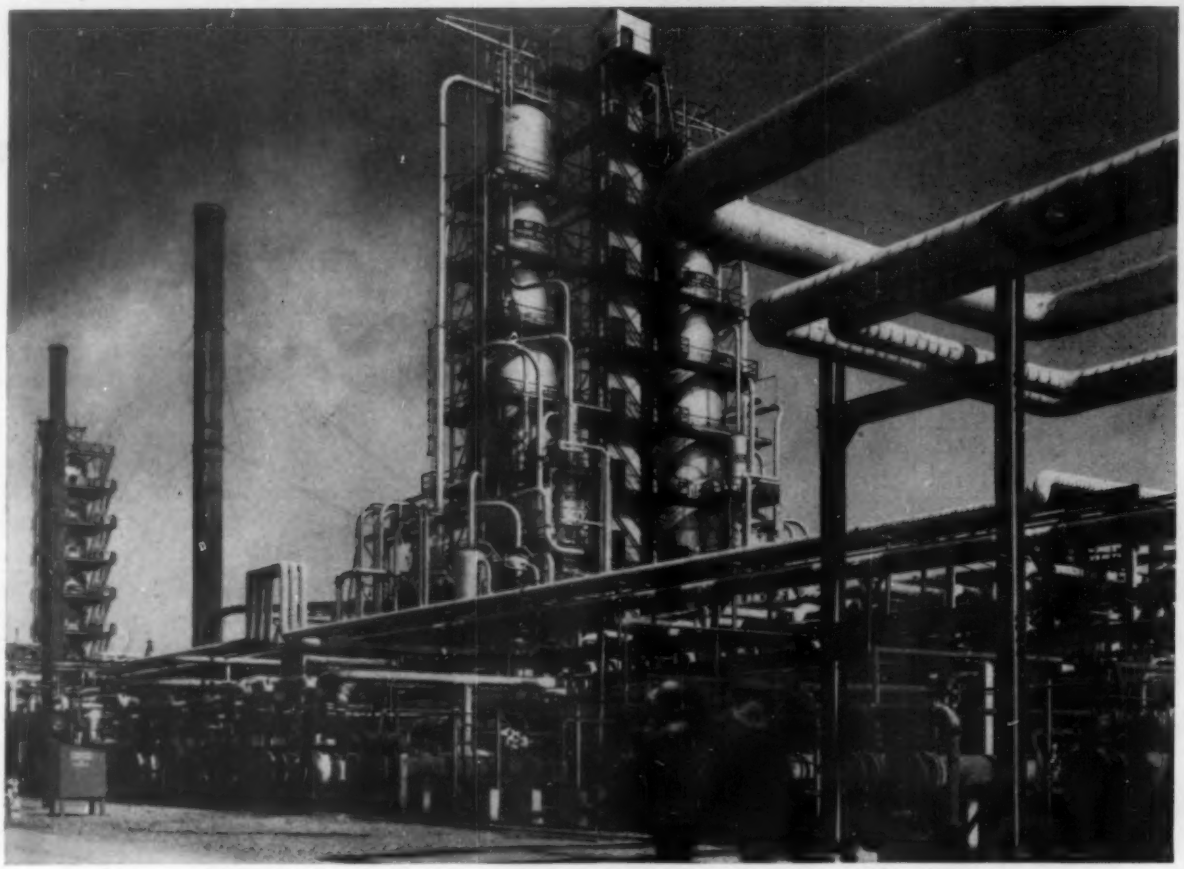
CORROSION CONTROL?



use Calgon Engineering Service for
LOWER COSTS/BETTER RESULTS

Piping, heat exchangers and condensers are the prime targets for corrosion damage in any cooling system. This is where Calgon Engineering Service can save money and lower corrosion rates. Calgon Service starts with a survey of the system, and includes water analysis both at the source and in use, plus a review of flow rates, temperatures, equipment type and usage and all other factors. This is followed by treatment recommendations and training of plant personnel. Here is why Calgon Service can save you money and maintenance:

LOWER CHEMICAL COSTS. In most systems, treatment is substantially lower in cost. This is not only because of more effective treatment, but also because, in many cases, smaller amounts of chemicals can be used.

LOWER WATER COSTS. With more effective treatment, it is usually possible to maintain higher solid concentrations in cooling water. This means less makeup water, and consequent savings in overall water costs.

BETTER RESULTS. In one typical plant, water treatment in use resulted in a corrosion rate of 4 mils per year. When Calgon Engineering Service took over, corrosion rates were reduced to 1 mil per year, and chemical costs came down at the same time.

A letter or phone call will put Calgon Engineering Service to work on your particular problem. Experience with every type of water problem in all parts of the country is at your service.

CALGON COMPANY
DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PA.
In Canada: Hagan Corporation (Canada) Limited, Toronto

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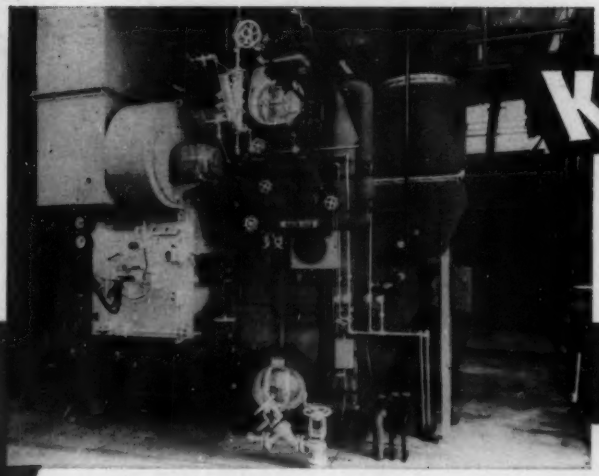

HERE'S THE GRAPHIC PICTURE of how

KEELER

supplied the nation's new steam requirements during 1958 . . .

KEELER STEAM GENERATOR SALES—1958

(*indicates more than one unit)

ABBOTTS DAIRIES
ADAMS STATE COLLEGE*
AGNEW STATE HOSPITAL*
ALICE MANUFACTURING CO.
AMERICAN CHICLE CO.*
ARMY MAP SERVICE, INC.
ATOMIC ENERGY COMM.*
BARCLAY ELEM. SCHOOL*
BARRETT LEATHER CO.
BREESE, CITY OF
CAMDEN HIGH SCHOOL
CENTRAL LAUNDRIES CO.
CHICAGO TOWEL CO.
CHINA TRADE & IND. SERV.
CHIPPEWA COUNTY HOSP.*
CITIZENS GEN. HOSPITAL
CONCRETE STRUCTURES
CONTINENTAL CAN CO., INC.
ROBT. GAIR PAPER PROD.
COOPER HOSPITAL
DANE CO. HOSP. & HOME*
DEARBORN CIVIC CENTER*
DIXIE CUP CO.
DOLL PAPER CO.
EASTERN HIGH SCHOOL*
EASTERN STATE HOSPITAL
EBENSBURG STATE SCHOOL AND HOSPITAL*
EVANS & CO., JOHN H.*
FLOYD BENNETT FIELD*
FORT LEONARD WOOD*
FORT STEWART*
FRANCE REFRACTORIES CO.
FRENCH CO., R. T.
GALLAUDET COLLEGE
GAYLORD CONTAINER CORP.
GEIGY CHEMICAL CORP.
GENERAL MILK CO.*
GEORGETOWN UNIV. HOSP.
GLEN MILLS SCHOOL
GRANT HOSPITAL*
GRIFFISS AIR FORCE BASE
HAGERSTOWN RUBBER CO.
INTERSTATE CONTAINER CO., READING CRGTD. DIV.
JUNIATA COLLEGE
KANSAS STATE PEN.
KENT COUNTY HOSPITAL*
KEYSTONE RFG. & MFG. CO.
LANCASTER LEAF TOB. CO.
LANKENAU HOSPITAL
LEA & CO., DAVID M.
LINCOLN AIR FORCE BASE
LODI REALTY CORP.
LONGWOOD GARDENS EST.
THE MARTIN COMPANY
MARYLAND RIBBON CO.
Wm. McKINLEY MEM. HOSP.*
MEMORIAL HOSP., Wake Co.*
MERCY COLLEGE
MILLERSVILLE STATE TEACHERS COLLEGE
MONTGOMERY HOSPITAL
MORGAN PAPER CO., INC.
MOSS REALTY CO.
MUSSELMAN CO., C. H.
NEW JERSEY NAT. GAS CO.
NORTHAMPTON CO. HOME
OAKWOOD HOSPITAL
PACIFIC GAS & ELEC. CO.*
PALACE LAUNDRY
PENNCO DISTILLERS, INC.
PIGEON FALLS COOPERATIVE CREAMERIES
POINSETT HOTEL
REEDVILLE OIL & GUANO Co.
RELIABLE KNIT PROC. CO.
M. H. RENKEN DAIRY CO., UNITED CREAMERIES DIV.
ST. CHARLES HOSPITAL
ST. FRANCIS HOSPITAL
ST. FRANCIS VOC. SCHOOL
ST. JOHN'S HOSPITAL
ST. LAWRENCE HOSPITAL
ST. LAWRENCE UNIVERSITY*
ST. MARKS HOSPITAL
ST. MARY'S HOSP. & CONV.*
SCHWEITZER, INC., Peter J.
SCOTT HIGH SCH., Jessup W.*
SMITH-CORONA MARCHANT*
SNOW COLLEGE
SOUTHWEST MO. STATE TEACHERS COLLEGE*
STATE FARM SHOW BLDGS.*
SWIFT & COMPANY
UNION CARBIDE & CHEMICAL CORP.*
UNITED AIRLINES, INC.*
U.S. AIR FORCE, AERO. CHART & INF. CTR.*
U.S. COAST GUARD*
U.S. TERMINAL ISLAND
VASSAR BROTHERS HOSP.
WINTZER CO., G. A.
WISCONSIN STATE COLLEGE
WOODROW WILSON REHABILITATION CTR.
WYOMISSING GLAZED PAPER COMPANY*

Each dot on the map indicates a new Keeler Steam Generator sold for various points throughout the nation during 1958. These installations represent an approximate 3,000,000 lb/hr rated steam capacity added during 1958 to serve the power, process, heat and special steam needs of the distinguished group of purchasers listed.

See for yourself why more and more steam users have come to rely on Keeler over the years! There's a size and type available for your requirements, from low cost package units to 80,000 lb/hr and field erected units up to 200,000 lbs stm/hr capacity—for all fuels and all types of firing!

You'll find Keeler's 95 years' experience in producing thousands of steam generators for domestic and foreign use is your assurance of a reliable, efficient source of low cost steam. *Write for illustrated bulletins, full data . . .*

E. KEELER CO. • 100-200 West St., Williamsport, Penna.

Offices in principal cities — In Canada: Canadian Vickers, Ltd., Montreal, P. Q.

1864/1959
95th ANNIVERSARY

The Seal of Quality in Water Tube Steam Generators

KEELER WATER TUBE Boilers

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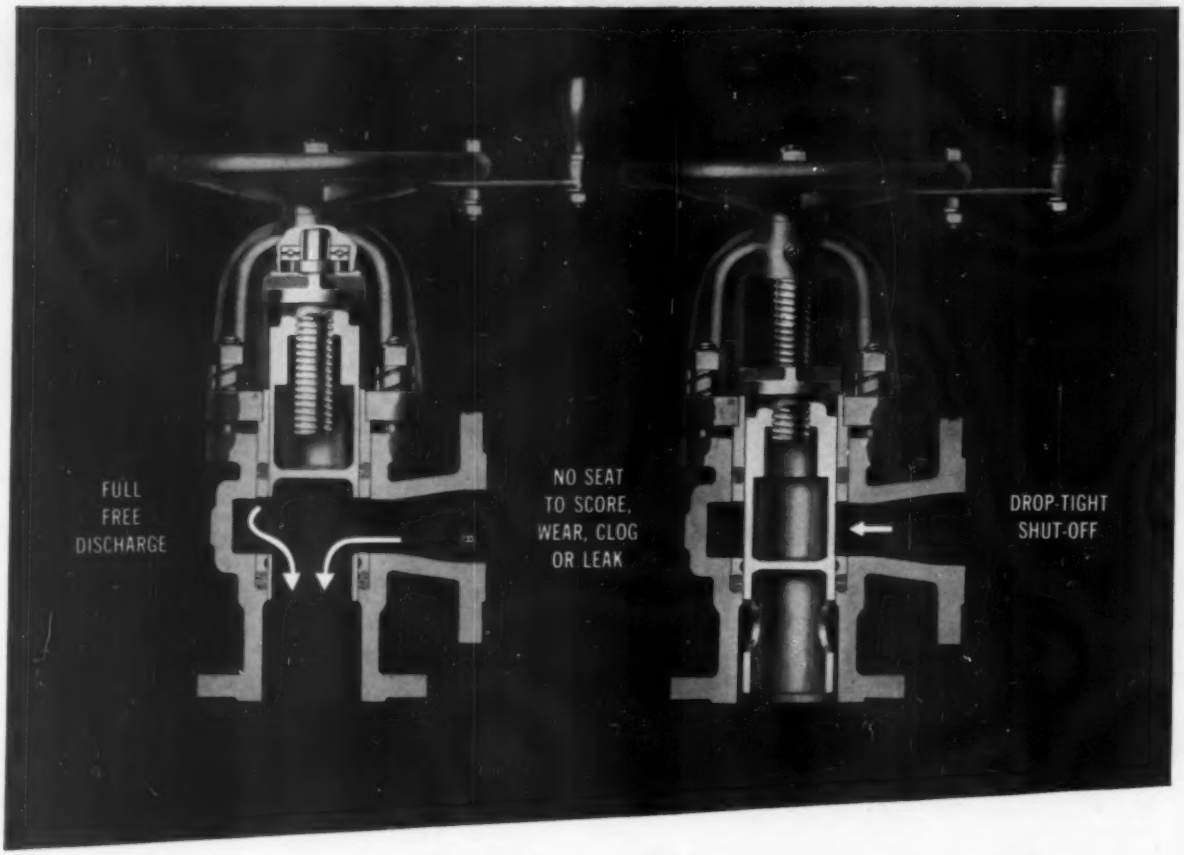

open and shut case!

...FOR TROUBLE-FREE PERFORMANCE WITH YARWAY SEATLESS BLOW-OFF VALVES

Mention Yarway Seatless Blow-Off Valves in more than 16,000 boiler plants, and you'll get solid approval—for these plants have first-hand *experience* with the dependable, trouble-free, service of Yarways.

For boiler blow-down service at all pressures up to 415 psi, YARWAY SEATLESS (in tandem) is the popular choice.

Outstanding feature is the famous seatless design—*there is no seat to score, wear, clog or leak*. Nitralloy hollow sliding plunger permits full, free discharge, yet keeps valve drop-tight in closed position. *No other blow-off valve has these features.*

Specify Yarway Seatless Valves when ordering new boilers and when replacing worn or inefficient blow-off valves on your present boilers.

Yarway Bulletin B-427 gives full information. Write for it today.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

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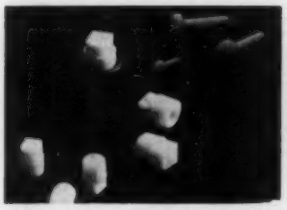
TRACERS

Power Engineering's Monthly Probe of Power Facts



Pipe plugs of DuPont's Delrin acetal resin will be available when the material goes into commercial production. Advantages are corrosion resistance, easy fabrication, light weight. Seals against pressures as high as 10,000 psi have been achieved in field tests. Hollowed-out center of the plug is said to increase thread-sealing ability as pressure is applied.

Hydrogen blistering of process equipment can be prevented by adding a small amount of an alkyl pyridine to the process stream, reports Union Carbide Chemicals Co. Addition of 50 ppm of alkyl pyridine to a solution of 5 per cent sodium chloride and 900-ppm hydrogen sulfide effectively stopped both corrosion and hydrogen blistering of a steel probe immersed for seven days.

Have a problem in time-consuming and costly cutting of heavy materials? There's a revolutionary new power tool available. It's a powder-lance that uses oxygen and a metallic powder to cut any thickness of concrete or steel — for less. R. L. Burch describes it on page 74, this issue.

The trend is up. Combustion Engineering reports having sold 38 units for use in the 2400-lb pressure range and above. Along with higher pressure the trend is toward higher unit capacities. C-E predicts that in another year the average size of h-p units should be up to 250 mw, as compared to the average now of 200 mw.

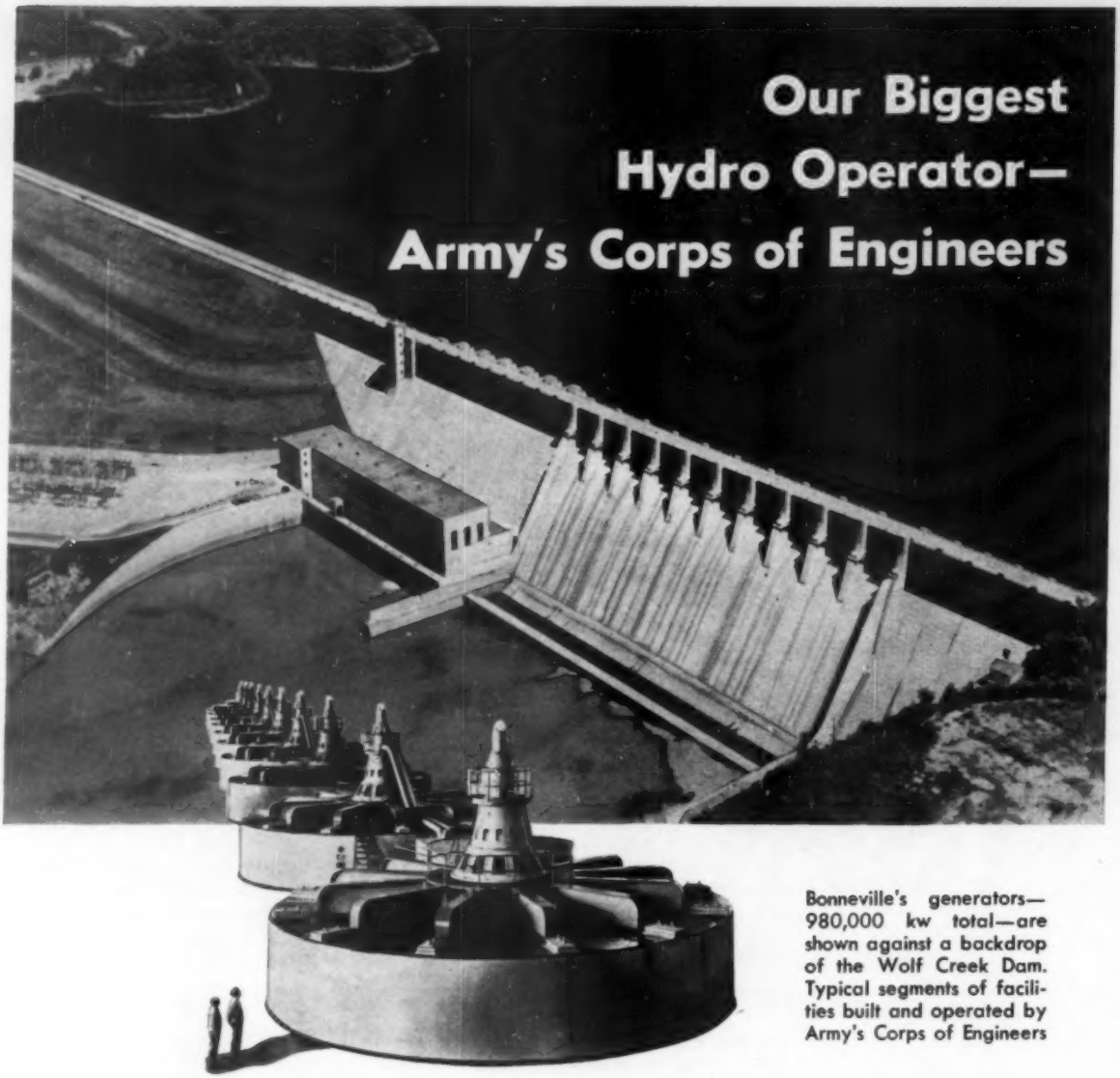
Did you know that about one-fifth of the hydroelectric power generating capacity in the U. S. today is installed at projects built and operated by the U. S. Army Corps of Engineers? For an over-all picture of this interesting operation, turn to page 70.

Instead of using steam from the main units for soot blowing, this service at Philadelphia Electric's new super-critical, super-pressure Eddystone Station will be supplied by three 500-psig, 39,500-lb-per-hour, oil-fired boilers. The auxiliary boilers will supply steam to long, retractable soot blowers and wall deslaggers which are operated electrically through selective-sequence automatic control.

Steam superheated by atomic power has been produced at Vallecitos Atomic Laboratory. The experiment is being conducted in an in-pile demonstration loop located in the core of the Vallecitos boiling water reactor. Uranium oxide ceramic fuel was used to superheat the steam from the reactor.

Nation's first rural electric coöperative substations using aluminum structures will be designed and built by GE for Randolph Electric Membership Corp of Ashboro, N. C.

Our Biggest Hydro Operator— Army's Corps of Engineers



Bonneville's generators—980,000 kw total—are shown against a backdrop of the Wolf Creek Dam. Typical segments of facilities built and operated by Army's Corps of Engineers

One factor resulting from nation's water resource development is a huge block of hydro power. Flood-control, irrigation, and navigation are primary objectives of this program. However, electric power generation totals over six million kilowatts from all dams operating

By Maj. Gen'l E. C. ITSCHNER *

ABOUT ONE-FIFTH of the hydroelectric power generating capacity in the United States today is installed at projects built and operated by the U. S. Army Corps of Engineers. This capacity has been added to the nation's power supply as a result of the application of principles of comprehensive water resource development to the Federal flood control and navigation programs.

Our rivers and lakes are among America's most valuable natural resources. They are also physiographic features which have greatly affected the nation's development, and will continue to have a significant influence in the future. They are the principal sources of water for our towns and industries. They carry vessels of trade, furnish power for our homes and businesses, and supply water to irrigate our lands. They provide food for our tables, and are widely used for recreation. The influence of these factors is attested by the fact that our large inland centers of population have largely grown up at favorable locations on our rivers and around our lakes; and, the least populated areas are generally those where water is scarce.

While they are the source of many benefits, these rivers can also be the cause of enormous economic losses and human misery when their waters rise in flood. The threat of flood alone can make the best agricultural land and industrial sites of little or no practical use.

Proper development of America's water resources can greatly benefit the economy of the country. If un-

* Chief of Engineers, U.S. Army

wisely developed and used, much of the wealth of our rivers can be wasted. A single dam can close off an entire channel for navigation, or destroy an important segment of our fisheries. A dam built with only one purpose in mind may foreclose the possibility of obtaining benefits from other purposes perhaps more important. If allowed to become polluted, a body of water may become practically useless as a source of water supply or for recreation.

It is most important that piecemeal development be avoided, and that all of the many factors involved be carefully weighed, when we proceed with the development and control of our water resources. The wisdom of this broad, comprehensive approach has come to be appreciated more and more as our understanding of the nation's water problems has increased. Today, it is firmly embodied in our laws and concepts governing waterway improvements.

The Federal Interest

Basic authority for the civil works activities of the Corps of Engineers is in Article 1, Section 8, of the Constitution, which delegates to the Congress the power to regulate commerce with foreign nations, and among the several States. In the earlier days, most of the work done on inland waterways under this authority was confined to the improvement of navigation. Since 1824, the Corps of Engineers has been the primary arm of the Federal Government operating in the field.

Since the latter part of the nineteenth century, however, there has been an increasing awareness of the necessity for considering other purposes in the use and conservation of water resources. This concern was reflected in the regulation of power developments by private interests on navigable streams. Prior to the passage of the Federal Water Power Act in 1920, primary control of such developments was vested in the Corps of Engineers; and, the Corps still functions in the regulatory field, where the interests of navigation and flood control are involved.

It was also reflected in the increased attention given to power, in planning water resource projects. As early as 1909 the Congress provided for data on water power possibilities — to be included in surveys made by the Corps of Engineers. This concept was reiterated and expanded in the years which followed.

However, it was not until 1927, when the Congress directed the preparation of what have become to be known as the "308" reports, that truly comprehensive planning on a nationwide basis began. As the result of this directive, the potential development of practically all of the river basins in the country was examined, and some 200 rivers were studied.

It is of interest that among the reports made by the Corps of Engineers to Congress are those for the Tennessee River. These formed the basis for the multiple-purpose development of that basin by the Tennessee Valley Authority.

Our Federal Government's water resource activities were again broadened by the Flood Control Act of 1936, when Congress accepted flood control as a Federal responsibility. The investigations directed by that Act, and in subsequent legislation, and the resulting studies and recommendations made by the Corps of Engineers, are the basis for most of the projects with power which have been constructed by the Corps.

Original Hydro Development

First large hydro generating unit installed by the Corps of Engineers was placed in service at the Bonneville Lock and Dam project in 1938. After World War II, the development of multiple-purpose water resource projects was greatly accelerated. And, today, hydroelectric power generating facilities have been included in 32 Corps of Engineers projects which are now in operation.

As of July 1, 1959, these projects have a total nameplate capacity of 6,104,400 kw in service. This is the largest amount of hydroelectric generating capacity under any organization in the country. Additional generating facilities, totaling 4,596,000 kw, are included in the program now underway, completion of which will bring the total capacity in service to over 10,700,000 kilowatts.

The locations of the Corps of Engineers' projects with power, which are in operation or under construction, are indicated in the table. Not shown are projects which have been developed by non-Federal interests, conformable to Corps of Engineers' plans.

Comprehensive Planning

Although widely distributed throughout the country, the various projects are generally associated with comprehensive plans for individual river basins. A brief examination of several of these plans indicates how power and other purposes are integrated into the over-all development.

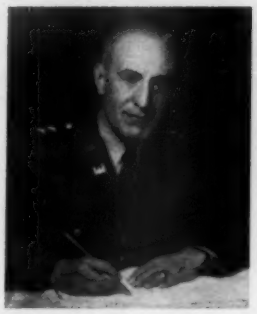
Columbia Basin offers the most attractive possibilities for development of power of any river in the country. Over half of the capacity in operation (or being installed by the Corps of Engineers) is located on the Columbia River and its tributaries. Although the power potential of this river is so immense that it somewhat overshadows other aspects, the river poses many problems and also presents many possibilities of improvement for other purposes.

All of these problems and uses are considered in the comprehensive plan toward which the Corps' efforts are directed, and the individual projects are all part of the over-all plan.

Basically, this plan involves the capture (in upstream storage reservoirs) of excess runoff that comes every year with the snow melt, and the release of it progressively through the system of dams and reservoirs downstream, when needed throughout the year for various purposes.

Retention of the snow melt, and spring rain, alleviates a very serious flood problem on the lower Columbia River, which would not be practical of solution in any other way. The regulation of flow which is afforded also makes practicable the extension of a navigation channel from the ocean to deep into the heart of the region. The lower river dams are arranged with this purpose in mind. Much of the stored water can be used to irrigate the vast, arid region which

About the Author



Major General Emerson C. Itschner is Chief of Engineers, United States Army. He is officially a resident of the State of Washington, although he is now living in Alexandria, Virginia. He is a graduate of the United States Military Academy, West Point, Class of 1924, and of Cornell University, 1926.

General Itschner has served in many engineering positions in the Corps of Engineers, on both its military and civil works activities. In World War II he was Engineer of the Advance Section Communications Zone in Europe. During the first year and a half of the Korean War, he was Engineer of the I Corps. He was Division Engineer, North Pacific Division, Corps of Engineers from 1952 to 1953, and he served as Assistant Chief of Engineers for Civil Works from 1953 until being appointed Chief of Engineers on October 1, 1956.

Recently, General Itschner was honored with the degree of Doctor of Engineering from Missouri School of Mines, University of Missouri.

Table shows location and capacity of plants in operation and under construction

No.	Location	River	Capacity (MW)
	IN OPERATION		
1.	Bonneville, Ore. & Wash.	Columbia	518.4
2.	Ft. Peck, Mont.	Missouri	85.0
3.	Norfork, Ark. & Mo.	North Fork	70.0
4.	Denison, Okla. & Tex.	Red	70.0
5.	Dale Hollow, Tenn.	Obey	54.0
6.	Allatoona, Georgia	Etowah	74.0
7.	Narrows, Arkansas	Little Mo.	17.0
8.	Center Hill, Tenn.	Caney Fork	135.0
9.	Wolf Creek, Kentucky	Cumberland	270.0
10.	St. Marys, Mich.	St. Marys	18.4
11.	Bull Shoals, Ark. & Mo.	White	160.0
12.	John H. Kerr, N. C. & Va.	Roanoke	204.0
13.	Clark Hill, Ga. & S. C.	Savannah	280.0
14.	Ft. Gibson, Okla.	Grand	45.0
15.	Whitney, Tex.	Brazos	30.0
16.	Detroit, Ore.	North Santiam	118.0
17.	Philpott, Virginia	Smith	14.0
18.	McNary, Ore. & Wash.	Columbia	980.0
19.	Tenkiller Ferry, Okla.	Illinois	34.0
20.	Ft. Randall, S. D.	Missouri	320.0
21.	Lookout Point, Ore.	Willamette	135.0
22.	Albeni Falls, Idaho	Pend Oreille	42.6
23.	Chief Joseph, Wash.	Columbia	1,024.0
24.	Blakely Mountain, Ark.	Ouachita	75.0
25.	Garrison, N. D.	Missouri	240.0
26.	Gavins Point, Neb. & S. D.	Missouri	100.0
27.	Jim Woodruff, Fla. & Ga.	Apalachicola	30.0
28.	Old Hickory, Tenn.	Cumberland	100.0
29.	The Dalles, Ore. & Wash.	Columbia	651.0
30.	Buford, Georgia	Chattahoochee	86.0
31.	Cheatham, Tenn.	Cumberland	24.0
32.	Table Rock, Mo. & Ark.	White	100.0
	TOTAL—Projects in Operation		6,104.4
	UNDER CONSTRUCTION		
2.	Ft. Peck, Mont.	Missouri	80.0
11.	Bull Shoals	White	90.0
25.	Garrison, N. D.	Missouri	160.0
29.	The Dalles	Columbia	468.0
31.	Cheatham	Cumberland	12.0
32.	Table Rock	White	100.0
33.	Cougar, Ore.	S. Fk., McKenzie	25.0
34.	Hills Creek, Ore.	M. Fk., Willamette	30.0
35.	Ice Harbor, Wash.	Snake	270.0
36.	Hartwell, Ga. & S. C.	Savannah	264.0
37.	Oahe, N. D. & S. D.	Missouri	595.0
38.	Walter F. George, Ala. & Ga.	Chattahoochee	130.0
39.	Greers Ferry, Ark.	Little Red	96.0
40.	Barkley, Ky. & Tenn.	Cumberland	130.0
41.	Eufaula, Okla.	Canadian	90.0
42.	Big Bend, S. D.	Missouri	468.0
43.	Dardanelle, Ark.	Arkansas	120.0
44.	McGee Bend, Texas	Angelina	52.0
45.	Beaver, Ark.	White	112.0
46.	John Day, Ore. & Wash.	Columbia	1,304.0
	TOTAL—Projects under Construction		4,596.0
	TOTAL—Operating and under Construction		10,700.4

lies between the Cascade and Rocky Mountains. Columbia River also supports one of the nation's principal salmon runs, and measures are being taken to preserve and (if possible) enhance this resource.

These regulated flows are used and reused through a series of power plants downstream, making possible the generation of large amounts of power — at a cost lower than that for any comparable region in the country. Power can be produced at the Chief Joseph project for a cost of only 1.2 mills per kwh. Average generation cost for a kilowatt hour of electricity, from all the plants of the Corps now in operation in the Northwest, *is less than 2 mills.* Availability of this low-cost power has been one of the principal stimulants to the phenomenal growth the Northwest has recently experienced.

Next in size to the Columbia Basin projects, in terms of power installations, is the system of six projects which the Corps of Engineers is constructing on the main stem of the Missouri River. These projects are all part of a comprehensive plan for the entire Missouri River Basin — serving flood-control, navigation, irrigation, power and other purposes, which the Corps and the Bureau of Reclamation are working toward coöperatively.

The six projects, which include several of the largest earth-fill dams ever constructed, have enough combined capacity to store the entire flow of the Missouri River in an average year. It seems probable that the waters of this large, unruly river would have continued to flow unchecked and wasted to the sea for many decades had it not been for the multiple-purpose approach. None of the purposes alone would have been economical.

Combination of purposes, however, has made possible a very attractive over-all development. This plan will supply an average of over seven billion kwh of electric energy annually, to what is a relatively high-cost power area — at a very reasonable cost of generation of 4.2 mills per kwh.

Allocation of Cost

About 30 per cent of this cost represents power's share of the cost of building and operating such facilities as dams and reservoirs, which serve all of the multiple purposes of the developments. The remaining 70 per cent covers cost for the specific power features provided to utilize the multiple-purpose facilities for power generation.

A more detailed breakdown of the components of the cost of generating power from the Missouri River projects is:

Components	*% of Total*
(A) Joint use facilities	
Investment	27
Operation and maintenance	3
(B) Specific power facilities	
Investment	
Powerhouse	12
Turbines & Generators	15
Power intake	22
Other	11
Operation and maintenance	10
	100

Planning for Power

The inherent advantage of comprehensive multiple-purpose planning is also apparent in the developments undertaken elsewhere in the country. These plans contemplate the optimum development, for all beneficial uses, of the Arkansas, White, Red, Brazos, Neches-Angelina, Cumberland, Roanoke, Savannah, Chattahoochee, and Alabama-Coosa river basins.

In practically every case, power has been made available more economically by its inclusion in a multiple-purpose project; and, in many cases, it would not otherwise have been feasible at all. Conversely, each Federal power project has made a great contribution to the welfare of the nation, by making possible many improvements for flood-control, navigation, and other purposes that otherwise could not have been justified.

Water resource development activities of the Corps of Engineers stem from the Federal Government's re-

Fort Randall Dam, Pickstown, S. D. This project provides flood-control, hydroelectric power, and water storage for drought

sponsibilities for flood control and navigation. However, power and other purposes are not relegated to a secondary role, when investigations are undertaken, under flood control or rivers and harbors legislation.

Power Consideration

Full and careful consideration is given to any power potential that may be developed. The same attention is given to other possible uses, with the objective of obtaining a balanced plan of improvement that will secure the maximum in sustained public benefits from all purposes.

Before power is recommended to the Congress, for inclusion in a project, it is subjected to rigid tests of feasibility. Power benefits are weighed against the costs that are necessary to include generating facilities, and power is not recommended for installation unless a favorable ratio is obtained.

In evaluating power benefits, the Corps conservatively uses as a measure the cost of developing equivalent power from the most economical alternative new source likely to be used. The salability of power is also examined to determine whether, under practical marketing conditions, sufficient revenues can be obtained to repay fully the cost chargeable to power.

Frequently, the installation of power is not found to be justified, but there are reasonable prospects that it may become so at some time in the future. If such is the case, appropriate provisions are made for a possible future installation so that the resource will be protected.

If power is feasible and a desirable part of the over-all plan, it is recommended for inclusion in the plan in reports submitted to Congress. Detailed designs and actual construction are never begun, however, until the Congress has considered and authorized the plan, and has appropriated funds specifically for the purpose. All civil works activities of the Corps of Engineers are carried out strictly in accordance with the directives of Congress.

A comprehensive plan, so devised, provides a framework within which all who are interested in some phase of water resource activities can participate in a way that will contribute to the over-all development. In fact, non-Federal interests have participated, in many instances, in providing the power features of a multiple-purpose plan or project.

Design and Construction

After a project has been authorized by Congress and funds have been appropriated, the design, preparation of plans, and supervision of construction is assigned to the District Engineer of the particular Corps of Engineers' District within which it is located.

The boundaries of these Districts generally conform to the outlines of the major river basins. Most of the detailed designs are handled by the permanent staff of the District office, although some of the work is awarded to architect-engineer firms, when the volume of work exceeds the capability of the permanent staff of the District office. All of the construction, on projects of this type, is handled by contract.

Method of Operation

Completed projects are operated by the Corps of Engineers, and careful attention is given to this phase of the program. This is to assure that the benefits from multiple-uses, for which the projects were designed, are actually obtained. This requires careful coördination of the operational requirements for the various purposes served.

When power and navigation are combined in a project, releases through the turbines must be patterned to supply the necessary flows, both in quantity and time, to maintain required channel depths. Present and future consumptive uses for purposes, such as irrigation and water supply, must be taken into account, and proper allowances made. Storage space must be made available when. and as, needed to retain flood flows.

Since flood control requires empty storage space, it is usually competitive with other purposes for storage. By careful planning, however, much use can be made of this space to increase power generation when flooding is not imminent. Consideration is also given to recreation, so that benefits from public use of the reservoir area may be obtained.

Capacity for Peaking

Most of the power stations in these multiple-purpose projects have been designed as *peaking plants* to serve as an integral part of the power supply system of the area in which they are located. This represents the highest, and best, utilization of the power resource for the area as a whole. It is an objective of project operations to achieve the maximum in power benefits, consistent with requirements for other purposes.

All power plants are operated and maintained by Corps of Engineers' personnel. Power generated over and above requirements for project operations is turned over to the Department of the Interior for disposal. Flood Control Act of 1944, and other

continued on page 124

More on Power Tools . . . . .

New Power Tool Cuts All Materials–Using Oxygen and Metallic Powder

Piercing and cutting of heavy materials has always been time-consuming and costly. Now, a powder-lance utilizes oxygen and a metallic powder to cut any thickness of concrete or steel. Cost-savings up to 40 per cent are reported with this ingenious method

By R. L. BURCH*

PACKING INCREDIBLE power, capable of piercing and cutting every material known to man, a revolutionary new tool is finding its place in industry. Known as the *Oxweld ACL-3 Powder Lance*, the new tool was developed by Linde Company, Division of Union Carbide Corporation. Nothing withstands the action of the new tool. Materials that were previously difficult, or impossible, to pierce with other methods can now be pierced and cut with comparative ease and speed by powder-lancing.

Accurate control of intense heat is the key to operation of the new lance. Lengths of standard black iron pipe are fitted into the front end of the lance, which is connected to an oxygen supply and a source of special Oxweld metallic powder. The oxygen and metallic powder are mixed in the pipe and carried to the material being pierced, or cut, by the consumable pipe.

This mixture is ignited at the end of the iron pipe, producing an extremely high-temperature reaction that melts both ferrous or non-ferrous material in its path. Aluminum powder, added to the metallic powder, further intensifies the cutting reaction, making it possible to cut materials such as thick concrete.

Since extensive field tests indicate that there is *no limit* to the thickness of material that can be pierced by powder-lancing, it is expected that the new lance will find widespread use. On construction and demolition jobs, for example, the lance can be used to make vertical and horizontal cuts in concrete of any practical thickness, without noise or vibration. This makes it possible to carry on normal operations in buildings where powder-lancing operations are being performed, and allows work to be done in areas where noise can't be tolerated, such as in or near hospitals.

Lance Speeds Demolition Job

The new lance was used on a huge concrete demolition job at General Electric Company's General Engineering Laboratory, Schenectady, New York. The building formerly housed a pit having concrete safety walls up to 4 ft thick, for testing high-speed steam turbines. Part of the building is being converted into a new radiation laboratory. Before construction could get under way, however, the walls had to be modified and over 8000 cu ft of concrete removed.

Fig. 1. This Fourth-of-July display shows powder lance in action. Four-foot concrete is being cut into sections for removal. Heavy wall is part of old turbine test pit

This turbine testing pit was shaped hexagonally and consisted of two concrete safety walls, separated by six ft of packed sand; inner wall was three ft thick and the outer wall four ft thick. Both walls stood about 16 ft high. A large amount of this concrete had to be removed to meet construction specifications for the laboratory.

By powder-lancing, the concrete walls were cut into huge sections measuring 20 x 16 ft, and weighing up to 100 tons apiece. Cutting speed was about 4½ sq ft per hour. After each of the sections was severed, it was hoisted out of the pit by a 100-ton bridge crane and hauled away.

This project was handled by James E. Lowe & Sons, Inc, of Schenectady, New York, who estimate that powder-lancing saved 30 to 40 per cent over the cost of any other method.

Powder-lancing is best suited for work on very thick concrete or other materials. Concrete up to 18 in. thick can be cut most efficiently with this process, a mechanized operation whereby torches actually *tailor-cut* concrete. Accurate straight, or curved, cuts can be made at speeds ranging from one to two-and-one-half in. per minute.

High Cutting Speed

And, there is no appreciable decrease in cutting speed as the thickness of concrete increases, because gas volumes and powder feed are increased proportionately. Concrete eight in. thick can be cut at only slightly less speed than a cut in four-in. thick concrete. Steel reinforcements in the concrete do not reduce the cutting speed, since the steel burns and actually adds to the flame's cutting action.

On one job, a powder-cutting torch was used to demolish a 43 x 20 ft, rectangular, steel-reinforced concrete structure in a factory building at

*Development Planning Manager, Linde Co, Div of Union Carbide Corp

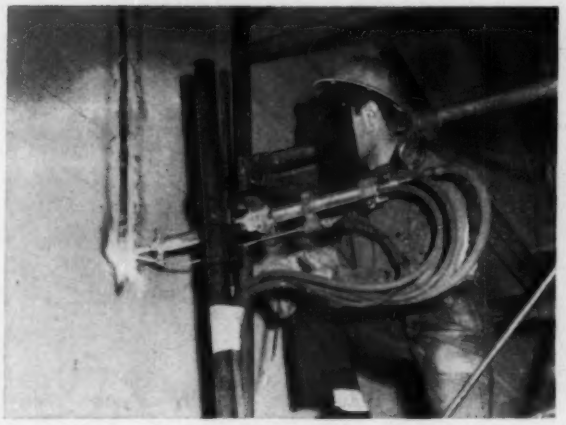


Fig. 2. Close-up of cutting action. Cuts are clean and sharp, making process ideal for carving openings in concrete walls or floors. Normally, operation requires cutting and patching

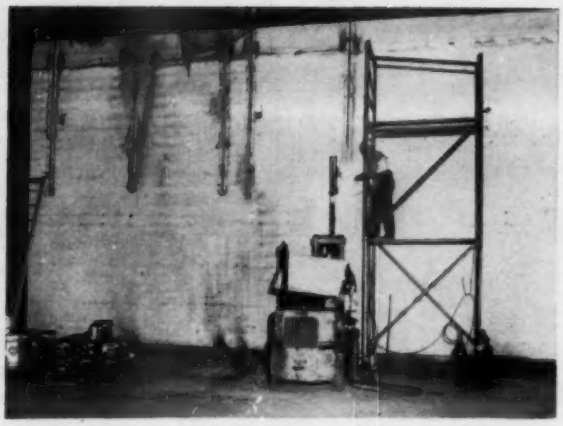


Fig. 3. Vertical cuts being made in double-reinforced concrete wall. Thickness of wall varies between 10 and 18 inches throughout. Reinforcing steel in concrete is no problem here

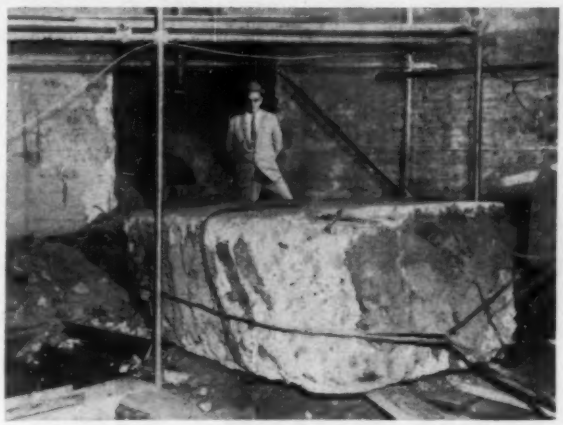


Fig. 4. Here is dramatic proof of powder-lance's effectiveness. Section of concrete has been cut, and is ready for removal. This wall section weighs many tons, but moved easily

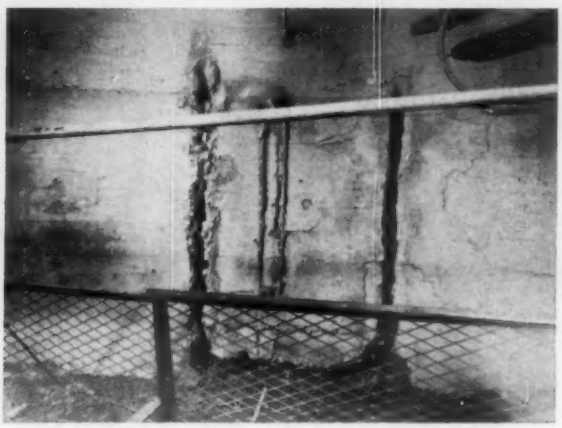


Fig. 5. Vertical cuts have been lanced in reinforced-concrete test pit wall. Horizontal cuts complete the operation of totally removing the complete wall section—without blasting

Tonawanda, New York. The structure had been used to house giant tanks. It had not been removed sooner because its design and location made it impossible to blast or crush without causing considerable damage to the rest of the building.

Lance Does the Trick

Using a standard Oxweld powder-cutting torch and special attachment, a total of 960 in. of cutting was done. The entire structure was removed, section by section, without interrupting normal operations in the factory building. The torch cut reinforced concrete, ranging in thickness from 10 to 24 in., at an average speed of one-and-one-half in. per minute. Concrete was cut into a total of 60 blocks, each weighing approximately three tons. The blocks were then hoisted on trucks and hauled away.

When the north span of the huge Peace River Bridge at Taylor, B. C., collapsed, a 36-ft long section was left precariously cantilevered from the last vertical cable. Heavy cutting units, or pneumatic hammers, could not be used since excessive weight or vibration might cause the section to collapse.

Powder-cutting and lancing proved to be ideal for this job because of the lack of vibration with the powder process and the lightweight and portability of the apparatus. Using a powder-cutting torch, the six-in. thick concrete decking was cut into sections 12-ft long and 4-ft wide. A lance was used to pierce a hole in the middle of each section so that a rigging cable could be run through the concrete. After each of the 2-ton sections was cut, it was removed by the rigging cable, which was attached to a chain block assembly.

Positioning Apparatus

A self-propelled cutting-machine carriage (with adjustable speed-control) meets all horizontal wall, level floor, or incline cutting requirements. Several techniques can be used for vertical cutting. For example, a lift truck hydraulic unit can be used to lower the torch along the line of cut. By positioning a bleed valve near the operator, he can regulate the downward rate of the hydraulic cylinder. Other arrangements can be used, such as a rig employing a lead-screw device.

No Blasting Required

Powder-cutting and powder-lancing of concrete are valuable demolition methods in locations where blasting cannot be employed, where time is an important factor, and where mechanical demolition methods are too costly. In remodeling work, break-throughs may be made in existing masonry walls without damage to the rest of the structure.

The powder torch can also be used for rough quarry work. In addition, the users of powder-cutting and powder-lancing will undoubtedly find new uses for these dramatic processes. This has been true in other cases, where new developments find new uses and result in continued industrial progress.

This is another valuable tool which will be of interest to all power engineers. Watch for more. THE END

Fig. 1. Poles stored in material yard

Fig. 2. Crossarm and insulator storage

Fig. 3. Line conductor on cable reels

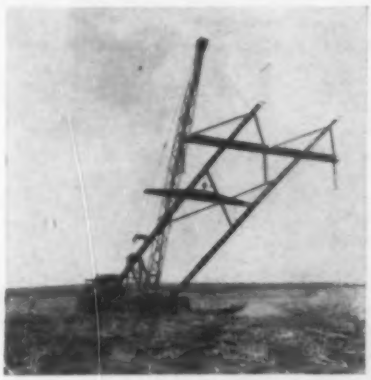


Fig. 7. Complete fixture being erected

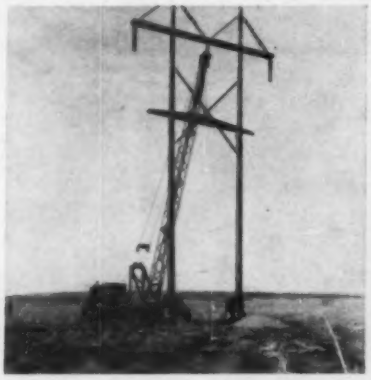


Fig. 8. Two-pole structure in the air

Fig. 9. Backfill and tamping operation

Electric Transmission Lines—How To Design and Build Them

This article concludes a three-part story on all phases of electric transmission line design and construction. Here the author relates details of construction, and energizing of line. An actual project is discussed, proving that planning and experience pay off

By E. P. NANEY*

IN ADDITION to asking for bids, either on a lump sum or a unit basis, we also request that each contractor give us a list of the various types of equipment he will use. This includes diggers, winch trucks, small trucks, pick-up trucks, and wire-stringing equipment.

Immediately upon receipt of bids, they are tabulated and analyzed, and the successful bidder is notified.

Signed contract contains, in addition to all of the above, a date of starting and a date of completion. This, incidentally, was stated in the bid specifications.

Before construction starts, we make provisions for receiving and storing all materials. (The contractor is expected to provide storage facilities for his own equipment and office use.)

During the course of construction, Interstate handles the field supervision inspection of the work through a field-inspection organization, consisting of a field superintendent and a minimum of one inspector to a job. We supplement this by inspection assistance from our district operating organizations. They, in the final analysis, must be familiar with the quality of workmanship, as they will be charged with taking over and operating the line when completed.

Figures 1, 2 and 3 show a storage yard for a line-construction job. It is apparent that thousands of dollars worth of material are stored here. Since the job is highly-engineered and the storage facilities are on a job-basis, the material is taken into stores as received, and disbursed to the job as used. This is done with little difficulty and a small amount of paper work.

Any items of material that are left over, after completion, are credited to the job and returned to the company's regular district storerooms.

Contract work of erection ordinarily divides itself into four or five production-line operations. Clearing of right-of-way, of course, is ordinarily contracted ahead of the main erection contract. This precedes the erection work by a sufficient amount of lead-time to give a cleared right-of-way for the material-distribution crews.

First work done by the construction contractor, after getting his equipment unloaded and getting organized, is to start hauling and distribution of materials from the

*Chief Electrical Engineer, Interstate Power Co. Dubuque, Iowa.

Fig. 4. Winch truck distributing poles

Fig. 5. Line poles spotted on location

Fig. 6. Hole digging, with power digger

Fig. 10. Three-pole corner fixture rises

Fig. 11. Conductors are strung on poles

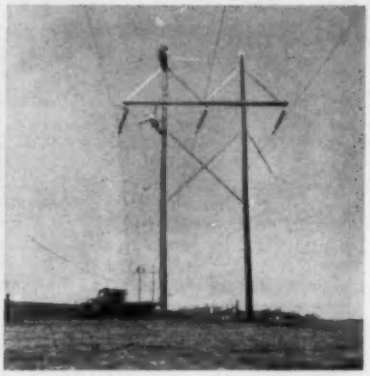


Fig. 12. Sagging, plus tie-in operation

storage yards to the individual structure sites. See Fig. 4.

This is followed by an assembly crew which, by use of light power equipment, installs the cross-arms, "X" braces, hardware and insulators on the pole structures to be erected. (This operation is not shown in photos.)

A setting crew, which is equipped with mechanical digging equipment, erecting derrick, and mechanical back-fill tampers, erects the previously-assembled structures. Figures 6 to 9 show the various steps in the digging of holes, and erecting of an H-frame structure. Figures 6 and 10 show use of two pieces of equipment used, and the erection of a three-pole angle-structure.

Separate Crew Goes to Work

After sufficient structures are erected, a separate crew will start the wire-stringing, sagging and clipping-in of the shield-wire and phase-conductors of the line.

A clean-up crew finishes the structure grounds, after they have been individually tested, and handles all of the small items of unfinished work. This includes cleaning up the premises of the property-owners, repairing damaged property, and settling with the property-owners for any damage created.

No transmission line is installed without terminals which automatically switch off the line in case of trouble. Engineering for the substation and line-switching terminal equipment is done concurrently with the engineering for the line. Installation of the terminal equipment may be given to a substation contractor, or it may be done by company forces.

After the line is completed, our own line and maintenance crews climb each structure, give it a final inspection, and correct all deficiencies. These consist, for the most part, of unspread cotter keys, loose hardware and other items not apparent from the ground.

Our test and maintenance department tests the circuitry of the automatic controls (oil circuit-breakers and reclosing equipment), that switch the lines during normal and trouble conditions. After they have sequence-tested all of these control circuits and found them to be operating correctly, the line is turned over to the transmission operating section, which authorizes the system load-dispatcher to energize the line and place it in active operation.

On transmission lines which require transformations to different voltages, the selection of transformation equipment is related more to the short term planning than for the long term. Site provisions will be made, at time of real estate purchase, to enlarge it as the load increases. (For example, we might buy a substation site of several acres but use only a small part, initially.)

Substations and switching stations accommodate themselves to long-term planning, for load growth, in several ways. It is possible to install a substation structure whose height, spacing, size of bus conductor, and insulation are designed and installed for a higher voltage.

Planning Layouts

If it is known that a higher voltage will be superimposed on the present transmission system, layouts must be so planned. Then, the initial structure must be located so the higher-voltage structure can be constructed at some future time, without rearranging existing structures (and with a minimum of interference from the original structures).

Distribution substations, which transform directly from transmission to distribution voltages, are engineered in the same manner. That is, the ground-space requirements, and the structure requirements, may be engineered to accommodate a future voltage increase. Transformers for these stations are never sized to accommodate a load increase of over 100 per cent. When load reaches that point, substation capacity may be increased by installing a second

Table I. Here is a bill of material with a listing of the items for a typical transmission line fixture, as discussed in the text

Pole, Wrc.—See Pole & Struc. Recap		Anchor Rod, 1 X 8 Twin Eye	Graybar 8538
Structure Assembly	Hughes Bros.	Guy Wire, ½ 7 Strand	Graybar
Insulator, 10 Susp. 15M	Lapp 8200	Guy Clamp, ½ Tubase	Joslyn J5022
Insulator, 10 Susp. 25M	G.E. 18255	Guy Clip, ½	Joslyn J1864
Clamp, 477 MCM ACSR D.E.	Bethea LS-6-S	Guy Wire, ⅜ 7 Strand	Graybar
Clamp, ⅜ E.H.S. Steel Susp.	Bethea GW-1	Guy Clamp, ⅜ Tubase	Joslyn J5038
Clamp, 477 MCM ACSR D.E.	Bethea ADE-24	Guy Clip, ⅜	Joslyn J1862
Clamp, ⅜ E.H.S. Steel D.E.	Bethea DF-20	Sleeve, 477 MCM ACSR Tension	Alcoa 10630
Ball Clevis	O.B. 70689	Sleeve, 477 MCM ACSR Loop	Alcoa 362
Anchor Shackle	O.B. 79608	Sleeve, ⅜ Steel Tension	Alcoa 807
Ground Wire, 4 Steel	Graybar	Sleeve, ⅜ Steel Loop	Joslyn J5038
Grd. Clamp, (Thru Type)	Burndy GBM-26	Damper, 477 MCM ACSR	Alcoa 1612B
Grd. Clamp, (D.E. Type)	Burndy GZ-4C12	Damper, ⅜ E.H.S. Steel	Alcoa 1603F
Moulding, Wood 6 Lengths	Mitchell	Armor Rod, 477 MCM ACSR Pref.	P.L.P. 78-AAR
Staple, Moulding 1⅛ X 3	Mitchell	Armor Rod, ⅜ Steel Pref.	P.L.P. 50-GAR
Staple, Grd. Wire ½ X 2	Joslyn J156	Zinc Chromate Paste	Alcoa
Grd. Rod, ⅝ X 10 Sectional	Joslyn J9160	477 MCM ACSR, 26/7 Strand	Alcoa
Grd. Rod Clamp, ⅝	Joslyn J8492	⅜ E.H.S. Steel Wire, 7 Strand	Graybar
Grd. Rod Coupling, ⅝	Joslyn J9182	Aerial Patrol Numbers	Prestoflex
P.G. Clamp, ⅜—4 Steel	Joslyn J5038	Aluminum Nail, 10D	Purchase locally
P.G. Clamp ½—4 Steel	Joslyn J5022	Extra X-Brace 15 6 P.S.	Hughes Bros.
Anchor, 250 sq. in. Crossplate	Chance X-20-1	Extra X-Brace 18 6 P.S.	Hughes Bros.
Anchor, 400 sq. in. Crossplate	Chance X-24	Switch Grid Grid Assembly	Misc. Matls.

duplicate transformer. Also, it may be done by transferring a larger transformer from some other station where an anticipated change makes a transformer available.

In the preceding portion of this story, we have discussed the engineering and construction considerations involved in constructing or developing a transmission system. Since it might be interesting to cite an actual project, we have selected one and will chronologically record stages of design and construction.

In mid-summer 1956, Interstate Power Co negotiated a contract to furnish power to the Northwestern Illinois Gas & Electric Co. At the time, there was reasonable assurance that an outright purchase of the property would be made. The problem, then, was how to integrate the property with the rest of the Interstate system, and to determine what part the integration would play in the area-planning for this part of the Interstate system.

The total load of the area to be served was 12,000 kw. This indicated that at least a 69-kv line would be required. Extending the load for a longer period of time, it became obvious that within ten years, the 69-kv line would no longer serve this purpose. It also happened that the property was so situated that, in serving it, the new line would eventually be a part of a second, and paralleling, line between two of the larger towns on Interstate system.

Therefore, the initial step of integrating the property, with Interstate system, should be with a line designed for eventual 161-kv operation, but which would operate temporarily at 69 kv. (This was verified on a network analyzer study. In this manner, the voltage, structure design, conductor size, and right-of-way requirements were settled in one decision.)

First section of the eventual total line was to be approximately 16 miles long and would traverse quite irregular, heavily-wooded country with very rough terrain. Use of aerial photographs permitted a quick selection of routing. The rough terrain indicated line costs above average and dictated that full advantage should be taken of diagonal routing, which was done.

Obtaining Right-of-Way

Immediately after route selection, property descriptions were obtained, and right-of-way buying was started. This included negotiating with communication-utilities, and obtaining railroad-crossing permits and certificates of convenience and necessity from State Public Utility Commission.

A large crew of right-of-way men was put on this job so that right-of-way could be assured as soon as possible. This, in turn, permitted early clearing of right-of-way. On this particular project, this was a very extensive operation and above-average in cost, due to the uniformly-heavy clearing over the line's entire route.

Due to the urgency of the project, a rough estimate was made of the material requirements, and sufficient supplies (including contingency material) were ordered — prior to the field survey engineering.

By the time the field engineering was completed, we were in position to let construction contracts. Actual work of construction was completed in the total elapsed time of 45 working days. Total project was planned, engineered, and completed in the total elapsed time of five months. This, we think, is near-record performance, in that planning, engineering, right-of-way purchase, clearing, and construction were going on simultaneously during the early period of the job. Table 2 shows the schedule set up for this project. It was executed very close to schedule.

On this particular project, the terminal substation voltages were determined by the voltage to be delivered to the receiving system. A wood substation structure was installed, in place of steel, for the sake of speed. In this particular case, it was known that the voltage from the new line would be raised to 161 kv.

Location of the structure on the site was such that only additions would have to be made later.

A transformer size was selected so it would last for a period of double the present load, after which time a second transformer could be added.

It might be of interest to know that our initial plans are proceeding as conceived. Our 161-kv construction is being extended in 1959, and will be further extended in 1960.

Indications are that the present line can remain in operation at 69 kv for the first ten years, after which the voltage will have to be raised to 161 kv. THE END

Table II shows the progress schedule for erection of a typical transmission line

ITEM	STARTING DATE	FINISH DATE	WORKING DAYS
1. Select Route	At once	Aug. 10	15
2. Easements	Aug. 15	Aug. 28	10
3. Purchase R/W	Aug. 20	Sept. 21	25
4. Clear R/W	Sept. 3	Oct. 26	40
5. Engr.-Survey	Aug. 29	Oct. 3	25
6. Order Material	At once	Aug. 10	15
7. Material Delivery	Aug. 10	Oct. 12	40
8. Construction	Oct. 15	Dec. 14	45
9. Test and energize	Dec. 14	Dec. 20	6

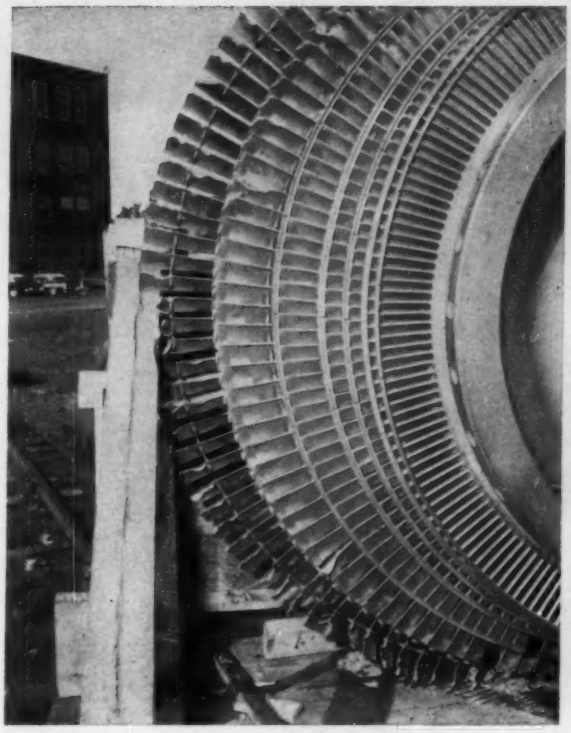


Fig. 1. Close-up of damage to the 16-in. and 25-in. blades on the IP-LP rotor, caused when shroud band was thrown off next-to-last row of blades. Taken when unit reached plant

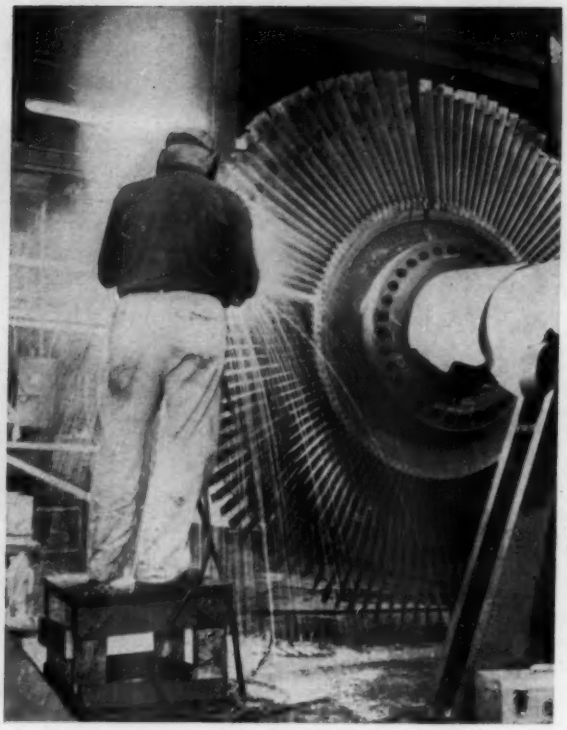


Fig. 2. First step in speedy repair job included cutting lashing wires connecting 25-in. blades prior to removal of damaged blades from rotor body. For next step, see Fig. 4

Memphis Turbine Repair Takes Only 34 Days, Shutdown to Startup

When shroud band failed on 250,000-kw unit at Thos. H. Allen Station, turbine rotor was shipped to Westinghouse, South Philadelphia, repaired there, returned to Memphis, all in 34 days: 10 days for transport, actual repair 8 days, handling and testing 16 days

AT 9:57 A.M. on June 4, the No. 3 unit at Thos. H. Allen Station of Memphis Light, Gas & Water Division suffered a mishap while undergoing its first overspeed test. It was not under load at the time. This is a 250,000-kw unit, with steam conditions of 2475 psi and 1050 F with single reheat to 1050.

As the turbine-generator reached trip-out speed of 111 per cent of rated speed (3600 rpm), a shroud band was thrown completely off the next-to-last row of blades on the low-pressure end of the intermediate-pressure element of the turbine. The band was thrown into the following row of stationary blades, and fragments worked into the last row of rotating blades, damaging them severely. Some pieces went into the condenser, where tubing was cut by flying fragments.

Theory was that shroud band rub might have caused enough heat to buckle the shroud band. Another speculation was that increased shroud thickness reduced length of the rivets extending beyond the shroud, also increasing centrifugal force on the band.

Turbine was immediately opened and completely dismantled, and it was determined that it should be returned to the factory for repair. It was loaded on freight cars and dispatched to the South Philadelphia Works of Westinghouse Electric Corp. John Powers, South Philadelphia shipping department, drove ahead of the car to insure fast and efficient switching at every rail center along the route from Memphis. Transit required five days.

Westinghouse worked around the clock, repairing and re-balancing the spindle, then made complete tests and returned the spindle to Memphis.

At 9:20 P.M., on July 8, the unit was again phased into the Memphis system after an outage period of 34 days, ten days of which were spent in transporting the spindle to and from the factory.

In completing repairs of this magnitude within a time span of eight days, Westinghouse undoubtedly has set a repair standard against which many future jobs will be gaged for many years to come.

It is interesting to speculate on the time that the repair would have taken if the turbine had been purchased from a foreign manufacturer.

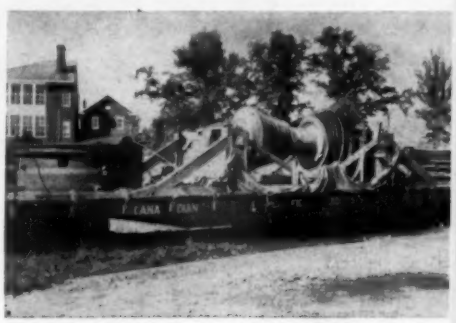
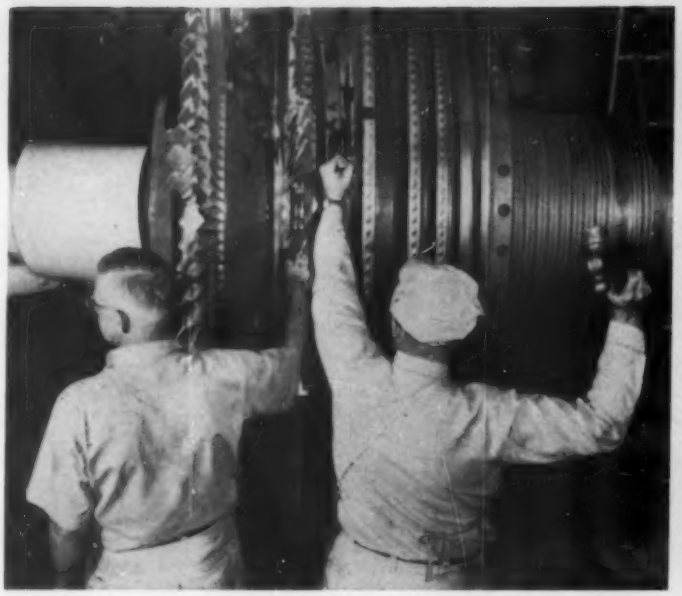


Fig. 3. Damaged rotor reaches S. Philadelphia. For what happened then, turn ▶



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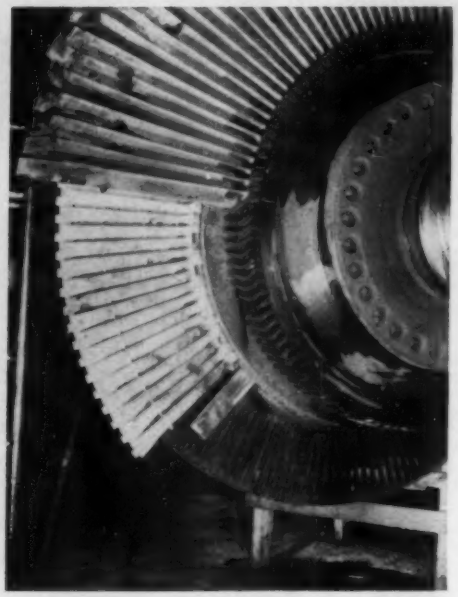

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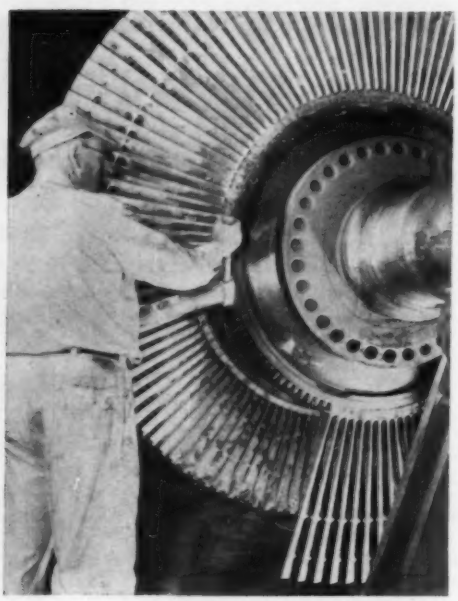

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Fig. 4. Early on June 15 the damaged spindle arrived from Memphis at the Westinghouse plant at South Philadelphia. By 2 pm, men were at work removing the damaged 16-in. blades and cutting lashing wire with arc on the 25-in. row

Fig. 5. By 5 pm that same day, June 15, removal of the damaged 25-in. blades had begun, while reblading of the 16-in. row was started. This view shows 25-in. row blades partially removed, with new 16-in. blades in row just ahead

Fig. 6. View taken at 5 pm, June 15, of blader inserting new blades in the 16-in. row grooves of the IP-LP rotor. All of the damaged 16-in. row had been removed by 2:30 pm, six hours after work was begun, and one-third of 25-in. row

Fig. 7. Second day of work, June 16, saw 16-in. row completely rebladed by 8:30 am, and 25-in. row completely removed by that time. At 10:30 am, work began on reblading the 25-in. row. This view of that work was taken at 11:30 am

on damaged Memphis rotor

8

9

Fig. 8. Reblading of the 25-in. row was completed by early afternoon on June 16, and work was begun on the welding of lashing wires to this row. This welding work continued next day

Fig. 9. Last stage of installation work on the 16-in. row involved putting on the shroud band. This was completed by 9 am on June 17. Here the workman is peening tenons which secure shroud

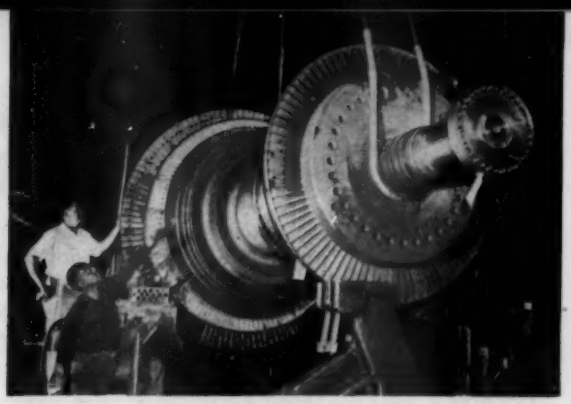


Fig. 10. June 18. Rebladed rotor is lowered into lathe for finish machining of shroud band and truth indication test

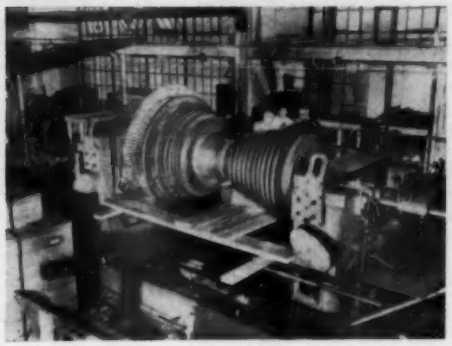


Fig. 11. June 19 at 2 pm. Machining completed, rotor is moved to the dynamic balancing machine

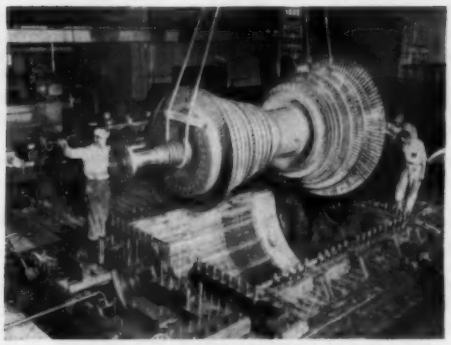


Fig. 12. On June 20 spindle shaft is painted, and tested for thermal stability and 120% overspeed

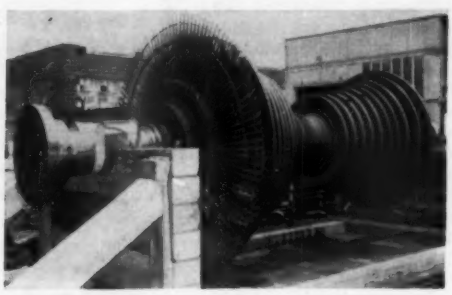


Fig. 13. Job is completed by 5 pm, June 23, and rotor is on car ready for shipment to Memphis

What the Power Engineer Needs to Know about Air Compressors

To meet his specific plant operating requirements, he first needs to know these fundamentals of air and gas compression, compressor terminology, compressor ratings, and details of reciprocating and rotary types of equipment, covered in this first of two articles

BELLOWS used by blacksmiths was probably the forerunner of modern air compressors. The bellows had an intake valve, a valve to prevent entry of air in the wrong direction, a means of compression, a discharge outlet, and a prime mover: the blacksmith's muscle.

Main variables of air (or any gas) are pressure, volume, and temperature, a change in any one of which may induce a change in the other variable.

Boyle's law states that, for a given weight of gas (or air) at constant temperature, volume varies inversely with pressure:

$$\frac{V}{V'} = \frac{P'}{P} \text{ or } V \text{ varies as } \frac{1}{P}$$

Thus, if we increase pressure on a gas, its volume will decrease. This is the principle upon which a gas, or air, compressor depends. It subjects the gas to pressure, compressing it and decreasing its volume.

Basic instrument for the use of compressed air (or gas) is the air compressor. A fundamental rule for the effective use of compressed air is that an ample supply of air must be available at the proper operating pressure.

To use the term in its broadest sense, compressors move a compressible fluid, air, or gas from any given suction pressure to some higher discharge pressure. If they move fluids with little pressure increase, they are called *fans* or *blowers*. If the suction pressure is below 14.7 psia, they are called vacuum pumps. If the suction pressure is above 14.7 psia, they are called *boosters* or *booster compressors*. If suction pressure is 14.7, they are simply called *compressors*. Suction pressures may be as low as 1×10^{-7} millimeters of mercury. Discharge pressures may be as high as 35,000 psig in some commercial processes. A standard air compressor, however, is one which compresses atmospheric air to a discharge pressure of 100 psig.

Many principles arise in compression: use of a second motive fluid (in diffusion pumps and ejectors), physical entrapment and positive compression (in positive reciprocators and rotaries), and radial or longitudinal acceleration by moving surfaces (in fans and blowers, and in centrifugal or axial-flow compressors).

Compressor application and selection, therefore, is of primary concern to those who desire to adapt the qualities of compressed air and gas to production, handling, and other uses. A compressor is a machine that takes air or gas at an initial intake pressure, usually atmospheric, and compresses the air or gas to a higher pressure.

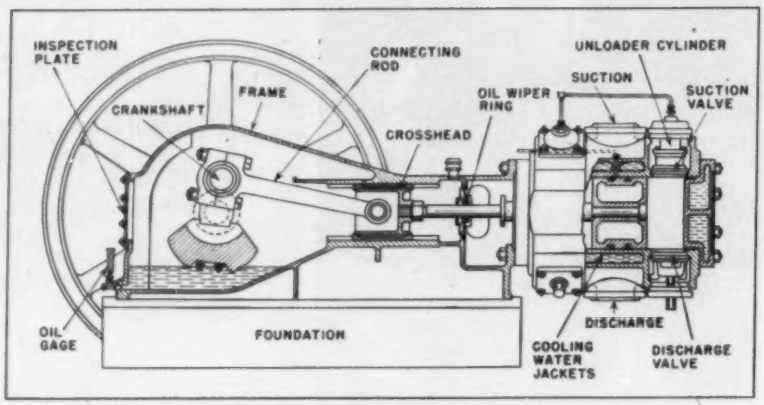


Fig. 1. Cut-away view of typical horizontal single-stage, water-cooled compressor

These machines are of two general types: 1. Positive-displacement type, wherein successive volumes of air are confined within a closed space in which pressure is increased as volume is decreased. Included in this category are reciprocating and rotary types. 2. Dynamic-type, wherein air is compressed by rotating members that impart velocity and pressure to the air. Included are centrifugal and axial-flow types.

Before discussing the main types of compressors, including their ratings, applications, selection and maintenance, it would perhaps be of advantage to establish some common terms of reference:

Reciprocating compressor — a machine wherein a piston (compressing element) follows a reciprocating motion in a cylinder to compress the air or gas.

Rotary compressor — a unit in which compression is accomplished by the action of a vaned rotor mounted eccentrically in a stationary casing.

Centrifugal compressor — a machine in which air is compressed by rotating elements, with flow in an axial direction.

Free (atmospheric) air — the air we breathe, with a pressure of 14.7 psi at sea level.

Compressed air — free air that has been forced into a space smaller than that which it would occupy in its free state.

Single-stage compressor — a machine in which compression, from initial to final pressure, is completed in a single step.

Multistage compressor — a machine in which compression is completed in

Why This Article

Every power station or boiler plant requires compressed air, provided by some form of compressor, and used for pneumatic controls, air tools, sometimes for soot blowing, and for general plant air. Power engineers must specify these compressors to meet their particular conditions. Hence, they should be well-grounded in compressor principles in order to recognize conditions that vary from plant to plant. They must select the right compressor and must also take into account inspection, lubrication and maintenance practices. These will be discussed in a second article in a subsequent issue. Watch for it.

two or more steps or stages. Such machines have large low-pressure cylinders and small cylinders for succeedingly higher pressure levels. Air discharged from the larger cylinder is compressed further in a small cylinder. Such machines are suitable for pressures above 100 psi.

Single-acting compressor — a machine in which compression takes place on but one stroke per revolution in each compressing element.

Compressors are sometimes rated on their piston displacement, possibly because the computation is a simple one. Displacement ratings may be misleading, however, and a free-air rating of the compressor is usually a more meaningful figure. The free-air rating is a measure of the air actually delivered by the compressor, and is always less than the displacement rating because no compressor has an efficiency of 100 per cent. Displacement rating, then, is a mathematical rating, while free-air rating is a rating of actual capacity. A third term, volumetric efficiency, derives from the two terms:

$$\text{Volumetric efficiency} = \frac{\text{Free air}}{\text{Displacement}}$$

Standard types of reciprocating compressors include the following:

1. Vertical and V-type single-acting compressors in which compression is effected in but one end of cylinder. These may be either air or water cooled; may be either single or two stages and range in sizes to 125 hp.

2. Vertical V- or Y-type with compression effected at both ends of the cylinder. They may be either single or multi-stage and range in sizes of 60 hp and up.

3. Horizontal or vertical, double-acting, water-cooled, single and multistage compressors, in sizes to 125hp.

4. Radial, vertical, double-acting, water-cooled, single and multi-stage compressors, in sizes up to 600 hp.

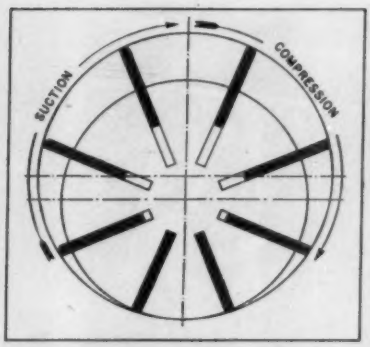


Fig. 2. Diagram showing operating cycle of a rotary sliding-vane compressor

5. Duplex compressors with cylinders mounted on parallel frames connected through a common crankshaft. These are horizontal double-acting, water-cooled, single and multi-stage units in sizes of 75 hp and up.

6. Horizontal opposed compressors with cylinders on opposite sides of the crankcase and with one crank throw per cylinder. These are double-acting, water-cooled, single and multistage units in sizes to 4500 hp.

A single-stage, reciprocating compressor is shown in Fig. 1.

Rotary Compressors Classified

Rotary compressors are classified in three categories:

1. Sliding vane compressors. These may, or may not, have floating rings. Floating rings prevent blades from bearing on cylinder walls. Those machines without floating rings have blade edges which contact the cylinder wall, as shown in Fig. 2. These are available in sizes to 5300 cfm, and with pressures to 125 psi.

2. Two-impeller positive displacement compressors. Such machines have two symmetrical impellers which are kept in position by gears. They are available in sizes to 50,000 cfm, at pressures to 30 psi.

3. Liquid piston compressors. These machines have a rotor which carries the compressant, a liquid such as water, in an elliptical casing. These machines have capacities up to 5000 cfm, develop pressures to 75 psi.

Another general type of compressor includes centrifugal (radial flow) and axial (flow in an axial direction) units. The rotating element that imparts velocity and pressure to the air in a centrifugal compressor is called an impeller. In an axial unit, one or more rows of rotating vanes serve to compress the air.

Centrifugal compressor impellers fall under three classifications: 1. Open-type, which has no closing cover and may be milled, cast in one piece, or built up; 2. Semi-closed type, which are closed on the back side only and, again, may be milled, cast on one piece, or built up from castings or forgings; 3. Closed type, which have an enclosing cover and hub disc, and are usually cast or built up.

Impeller blades are usually of two kinds: 1. Radial, straight blades that extend radially, and, 2., straight or curved blades, installed at an angle against direction of rotation.

A multistage centrifugal compressor, Fig. 3, has two or more impellers rotating in series on one shaft within a casing. Multistage axial compressors, like that shown in Fig. 4, feature two or more rows of vanes rotating in series on one rotor within a casing, which includes non-rotating vanes to guide the air (or gas) to the next stage, or row of rotating vanes.

To be continued.

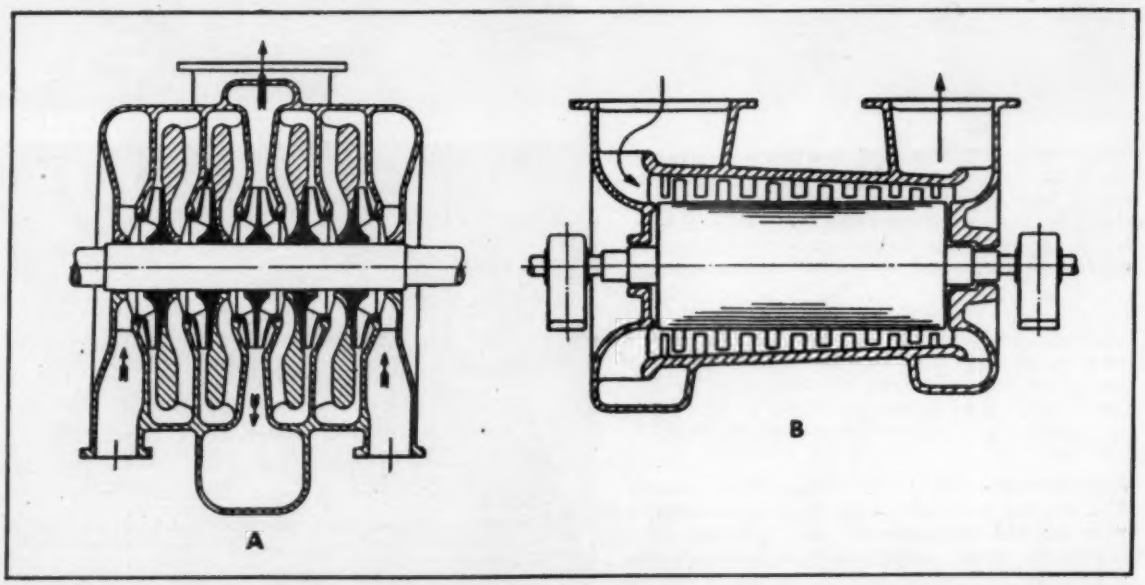
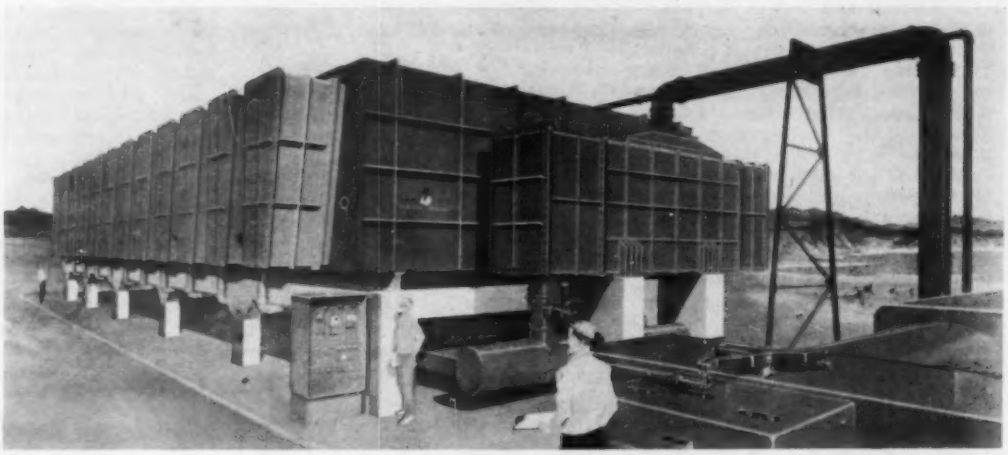


Fig. 3. Multi-stage centrifugal compressor A has two or more impellers on same shaft. B is a multi-stage axial compressor

400-lb paraffin slabs make unique shielding for Columbia U's new subcritical reactor, used for teaching nuclear engineering. Graphite for the exponential pile is from National Carbon Co

Unusual unloading technique for this Puerto Rico-bound GE generator stator will use about a million and a half pounds of sugar to weight down ship and bring freeboard even with dock



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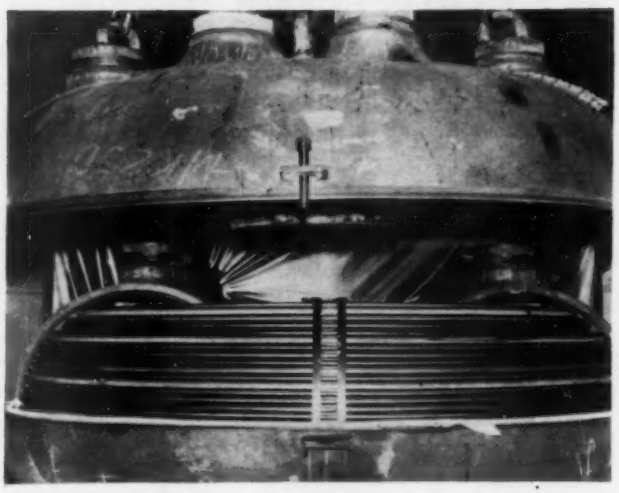
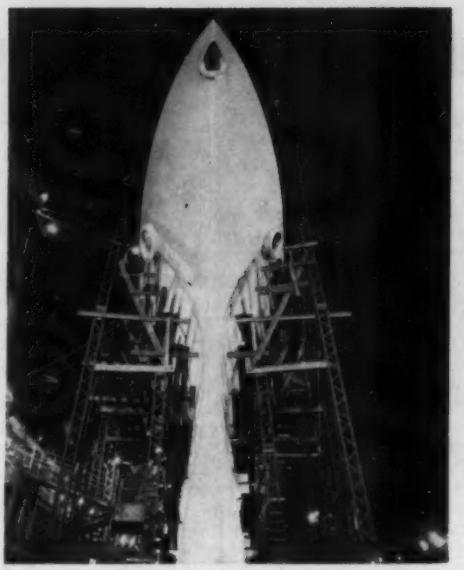
Sea water distilling plant, to process 1,250,000 gal a day, as conceived by designers at Cleaver-Brooks. Basis is flash evaporator principle. Company claims that using extraction steam from turbine as heat source, sea water can be converted to fresh for less than one-tenth of a cent per gal, with all costs included

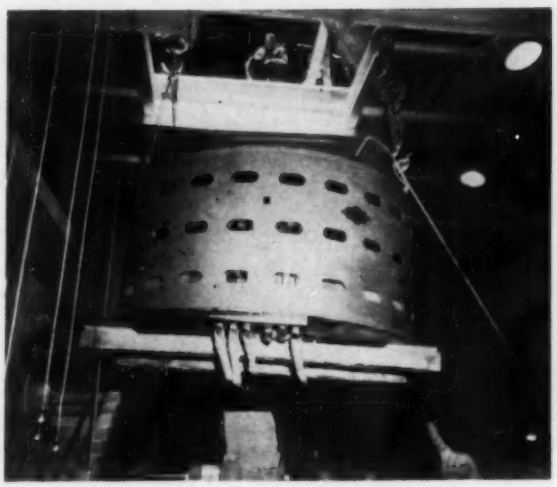


Atomic clam—shell of this mammoth "clam" contains 812 stainless steel tubes through which pressurized water, superheated to more than 500 F, circulates after leaving the reactor aboard the N. S. Savannah, first atom-powered merchant ship. This is one of two U-shaped Babcock & Wilcox heat exchangers in the ship

POWER ENGINEERING'S NEWS REEL



Cruiser Long Beach, Navy's first nuclear-powered surface vessel, nears completion at Bethlehem Shipbuilding. Ship's power plant will use two Westinghouse pressurized-water reactors



▲ **Steam generators** on test in shop of Erie City Iron Works are watched closely by a group of the company's field sales agents gathered at Erie, Penna, for a four-day sales conference. At left is a pressurized Keystone unit, at right a pressurized VLP, between them are FT fire-tube packaged boilers

Reins for 6,000,000 horses (above, left). Commonwealth Edison's new computer-controller regulates moment-to-moment output of electricity from 37 turbine generators with capacity of 4,634,000 kw, or almost 6,000,000 hp. Built by GE, the machine exactly matches output to demand

◀ **Down goes** a 3000-kw vertical waterwheel generator through the roof and into place inside the Williams Fork Dam powerhouse near Denver. Built by Electric Machinery Mfg Co, the machine will generate electricity which will be sold by Denver Water Board to Public Service Co of Colo

How to Choose and Use Your

This is the second part of Mr. Potts' three-part article, covering the various aspects important to the power engineer selecting and operating motors. Here the boiler-feed-pump motor, the largest and most expensive auxiliary motor, is discussed in considerable detail

By R. J. POTTS*

NOT ONLY does the 3600-rpm boiler-feed-pump motor represent the largest single horsepower unit in auxiliary drives, but it also has the highest dollar value. Utmost reliability is necessary in the boiler-feed-pump motor. It is essential that these motors in particular are scrutinized for adequate bearings, proper ventilation, reduced noise, mechanical sturdiness, and adequate mechanical bracing for across-the-line starting shock.

Critical Speed

Rotors of two-pole motors should have the critical speed well removed from the full-load operating speed. There are pros and cons as to placing the critical frequency somewhere between the zero-speed and the full-speed point (flexible), as well as placing the critical speed beyond the 3600-rpm point (rigid).

Discussion of shaft rigidity always ends with the realization that both approaches, if done with care, will produce favorable results. Problems that exist with the below-critical shaft disappear with the above-critical shaft, but new problems arise and vice versa. The above-critical shaft is inherently easier to build and is also easier to balance. The above-critical shaft generally is shorter with a larger diameter. For comparable horsepower ratings, peripheral speeds are greater and rotor stresses are higher. Because of these stresses it may be necessary to use more ductile lamination material, at a possible sacrifice of electrical quality.

It is difficult to raise the critical speed much above 120 per cent of the operating speed. At the same time, resonance occurs in the yoke structure. Yoke resonance is very hard to predict. It can occur at 20 per cent below the operating speed. With an above-critical shaft, the yoke resonance at 80 per cent and the critical rotor resonance at 120 per cent might actually reinforce each other at the operating speed. The fundamental, or some harmonic, can defeat the purpose for which the above-critical shaft was intended. The flexible shaft or below-critical shaft has no chance of yoke resonance, emphasizing oscillations at the operating speed.

Other Problems Appear

The unbalanced magnetic pull might be a slightly greater problem in the longer below-critical shaft than in the shorter above-critical shaft. The flexible shaft motor is thought by some to encourage oil whip. Oil whip or mechanical vibration is noticed on 3600-rpm motors at an average frequency of 1800 cycles per minute. If one looks in the bearing and considers the oil velocity at the shaft as 3600 rpm and the oil velocity at the bushing as 0 rpm, an 1800 cycles per minute average velocity is the result. One way of minimizing this situation is going to higher bearing pressures. Keeping the oil wedge confined to smaller areas increases the bearing pressure. The 90-degree bearing, or one in which the oil wedge is spread over one-

*Application Engineer, Motor and Generator Department, Allis-Chalmers Manufacturing Co

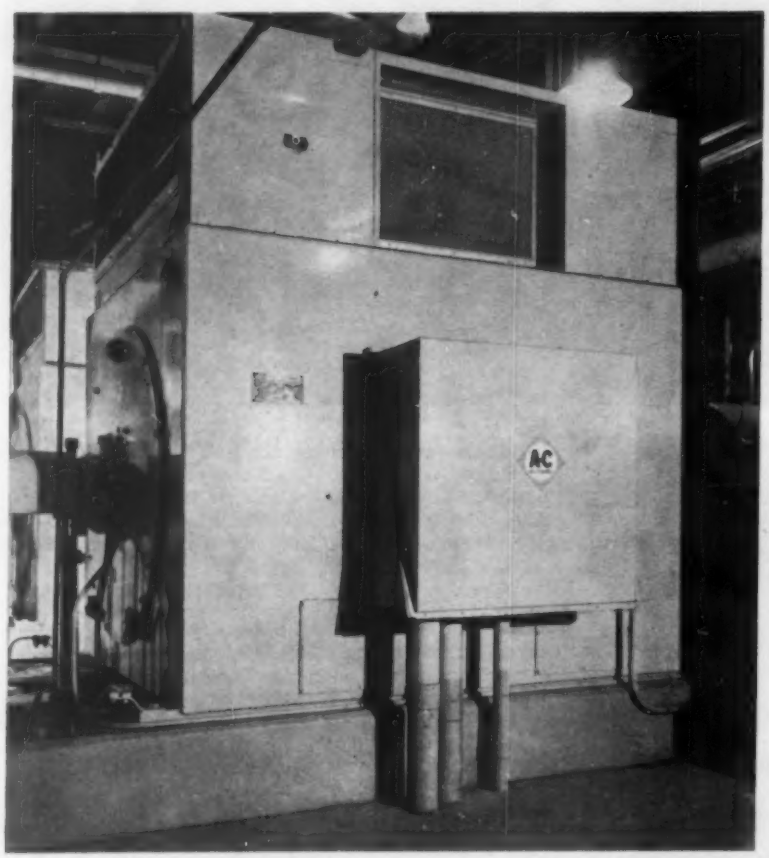


Fig. 1. Utmost reliability is a requirement for modern boiler-feed-pump motors. This motor is 4000-hp, 3580-rpm, 4000-v, with sound-reducing chambers on top

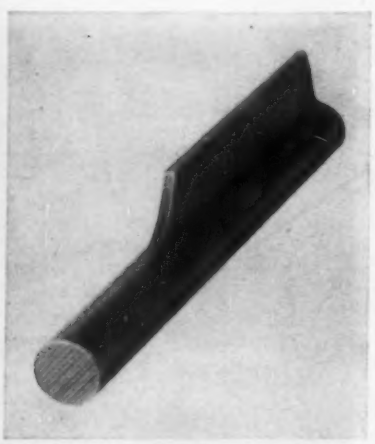


Fig. 2. Copper damping bar for rotor gives a high power factor on starting

Power Plant Motors Properly

fourth of the circumference of the bearing journal, is most effective in reducing oil whip.

Everything being considered, the below-critical speed shaft is a reliable approach to two-pole motors. In fact, it is difficult to observe the critical speed when accelerating up to the operating speed. The final decision of rigid or flexible shafts is based on weighing the virtues of each, but either method — if designed correctly — produces a long wearing, stable motor.

Rotor Construction

High-speed rotors should be of solid construction. The rotor is not only sturdier, but results in more quiet operation. Rotor laminations should be pre-stacked to obtain best mechanical results. Copper bars should be snug fit in the rotor laminations to minimize bar loosening due to centrifugal forces which are set up in the rotor.

Pre-stacking enables the rotor laminations to enjoy uniform pressures. By stacking the laminations in a mandrel, they are perfectly aligned and are more adaptable for placing on the rotor shaft. The pre-stacking under uniform pressure guards against tooth breakage of the rotor laminations.

Rotor bars themselves should be designed to give maximum starting torque and at the same time minimum starting current. In other words, the copper bars should allow high starting power factors, thus more of the inrush current is used up in output watts. A special "dew-drop bar" for this purpose is illustrated in Fig. 2.

To insure that the rotor does not buckle under thermal expansion of the copper rods, the copper rods should be allowed to expand. By mounting the end-ring structure on a spline, the end ring can move back and forth with the ends of the copper rods, Fig. 3.

Rods should be high-grade oxygen-free copper. A silver-brazed connection of the copper bars to the end ring establsihes a permanent bond. A ring on the end assembly can be used for balancing external to the rotor laminations. A protective high-strength retainer ring counteracts the centrifugal forces on the end ring.

It is essential to cool two-pole motors in a thorough and uniform way. Special arrangements should be used to distribute the air in even temperatures over the entire stator package. Merely causing the air to intake at the rotor end and discharge in the center of the stator will leave the stator cool at the ends and warm in the middle.

Uniform Cooling

A method such as spiral ventilation, as shown in Fig. 2 of the first part of this article, on page 84, August, 1959, POWER ENGINEERING, in which the incoming air is directed by fans and channeled through special ducts along the entire length of the stator before moving through the laminations, will provide more uniform cooling. With the stator laminations so arranged that alternate groups will have opposite sloped air ducts, adjacent air vents will have alternate cool and warm air which tends to even the over-all temperature. Spiral ventilation also has the added quality of reducing noise level.

Noise is in itself a nebulous thing. It is simple enough to standardize on the measurement of noise as set forth in the NEMA Standard MG-4.32, but the subject of judging noise is an entirely complex field. Noise levels have increased as machines have increased in horsepower.

Personnel working in the area next to loud noise sources suffer from fatigue, encounter physical damage, and produce at a low efficiency rate. Air-borne noise will also provoke criticism from adjacent residential areas. Noise can be reduced by observing specific designs and correcting the troublesome cause.

For instance, the ratio of stator teeth to rotor bars can be changed in some cases where particular frequencies are objectionable. If the noise cannot be "designed out," efficient methods of absorbing the noise can be used. Sound absorbing panels with special baffling can be installed integral with the motor so that the db reading on the C-scale of a standard decibel meter will be 90 db or below when measured five feet away from the motor, Fig. 5.

Boiler feed pumps are a source of much noise in themselves. Realizing that pumps are inherently more troublesome to correct for noise, as much as possible of the motor noise must be eliminated. This is a large problem when one realizes that noise reduction of three db requires sound power output reduction of one-half!

Lubrication

Special design is necessary on high-speed motor bearings to prevent oil suction into the motor and to protect bearing journal against failure. Two-pole motors, 900 hp and above, incorporate forced-feed lubrication. The forced-feed system would include a shaft-connected oil pump; an oil-sump reservoir below the bearing level, necessary piping between the oil sump and the bearings, an oil filter when necessary, and an oil cooler. Whether the boiler feed pump or the motor incorporates the preceding is

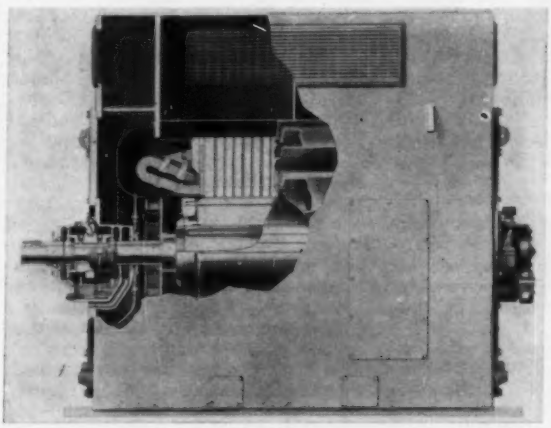


Fig. 3. Cut-away drawing of typical large two-pole squirrel-cage induction motor. Fig. 4 is a close-up of this bearing

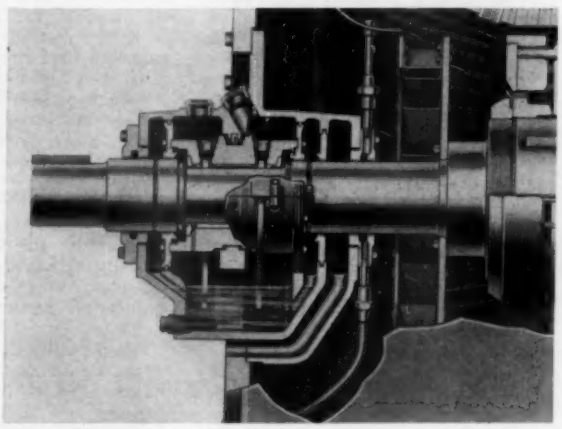


Fig. 4. Labyrinth seals, vented reservoir, and high-pressure air seal maintain non-oil-leaking high-speed sleeve bearing

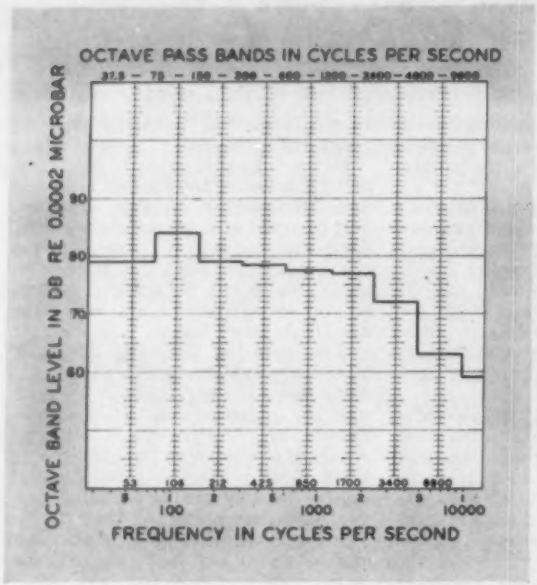


Fig. 5. Sound levels as recorded on the C scale of a decibel meter five feet from the acoustic cooling-air intake and discharge structure of a 2000-hp, 3850-rpm motor with baffling

immaterial. It is advantageous to provide an oil-sight-flow indicator for periodic inspection.

Pressurized oil should enter the bearing through a small orifice in the incoming line. This would maintain uniform oil flow and pressure (roughly ½ gal-per-minute per bearing at 5 lb). After passing through the orifice, the oil would reach the bearing journal itself. Before the oil would return to the discharge line, it would pass over a discharge weir. This keeps the oil maintained at a definite level within the bearing. Oil rings will support lubrication of the bearings for at least 30 minutes. However, the forced oil system, being primarily to cool the oil, should always receive proper maintenance and attention.

A typical high-speed bearing is shown in Fig. 4. Any excess oil on the bearing bushing will tend to flow through the relief holes, which are located at either end of the bearing journal, down to the oil reservoir.

Labyrinth seals are used on the rotor end and the outside end of the shaft to prevent oil creepage along the shaft. Relief grooves in the shaft allow the oil to drain back down through the oil-return vents to the oil reservoir. The oil reservoir is vented to atmospheric pressure through a copper mesh-type breather. The rotor end of the bearing is vented to atmospheric pressure to relieve any possible tendency to draw vapor at this point.

An excellent way of further minimizing oil suction into the motor is to bleed off air from the pressurized-air region immediately inside the coil-end air baffles and direct this air through an annular air-pressure chamber which is relieved to the atmosphere. This puts the entire rotor end of the bearing under positive pressure and eliminates oil suction into the motor.

Editor's note: In October, POWER ENGINEERING will publish the third portion of Mr. Potts' three-part article on electric motors, which will discuss the pertinent aspects of motors for circulating-water pumps, condensate pumps, induced- and forced-draft fans (including speed control), and mills and crushers. THE END

Good Heat Balance Makes for Adequate Design

"ACTUAL power plant design must incorporate equipment selected to meet basic requirements established by the type, size, and importance of the process it serves." So said R. W. Precious in a symposium on forward planning for the industrial plant before the American Power Conference recently.

Four factors enter into this selection, and each piece of equipment must be carefully analyzed to determine reliability, investment, flexibility and operating cost. Each new product to be manufactured by any industry requires at least one utility service, and generally more, according to Precious.

First consideration is how the new load will affect the steam and power balance. The power engineer must consult with the process engineers early in their design to study the effect on existing services and determine what, if any, variables can be considered to more economically supply needed utilities for process.

It is recognized that once steam generation at, say, 200 psi has been justified, it does not take a disproportionately greater investment to raise the pressure level to 600 psi and higher. In plants requiring process steam at various pressure and temperature levels, it is usually economical to generate all steam at a pressure equal to, or greater than, the highest process pressure required.

Normal process requirements include pumps and compressors, and these must be supplied with some form of driving energy. Herein lies the main use for the steam and power balance sheet. An ideal plant would generate high-pressure steam which, in turn, would be reduced in pressure by back-pressure turbine drives to supply the energy for pumps and compressors, or to generate electrical power for process.

Evolving Hot Condensate

Low-pressure exhaust steam could then pass through a series completely satisfying process heat requirements and then return to the boilers as uncontaminated hot condensate.

Such plants do not occur with any great frequency, according to Precious. Instead, process steam load is usually less than the corresponding horsepower equivalent of economical back-pressure turbine drives. Power engineers in industrial plants are usually faced with the installation of pressure-reducing for load flexibility, and the problem of whether to purchase a portion of the electrical power or justify internal generation on a straight condensing basis.

Even partial power generation on a back-pressure cycle must be evaluated accurately. Steam and power distribution systems must be constantly reviewed to permit a thorough analysis of the effect of new process loads. No new situation should be solved simply by doing what was done before or by what seems on the surface to be the best. Process requirements, distribution system, and economics must be analyzed and a steam and power balance prepared.

Importance of power services in industrial plant production cannot be underestimated. Cooling water, compressed air, steam and electric power may in themselves represent only a small portion of the actual cost of a final product. However, who can say what the services are worth if they become unavailable and production losses result? Thus, reliability becomes one of the prime factors influencing design of an industrial power plant.

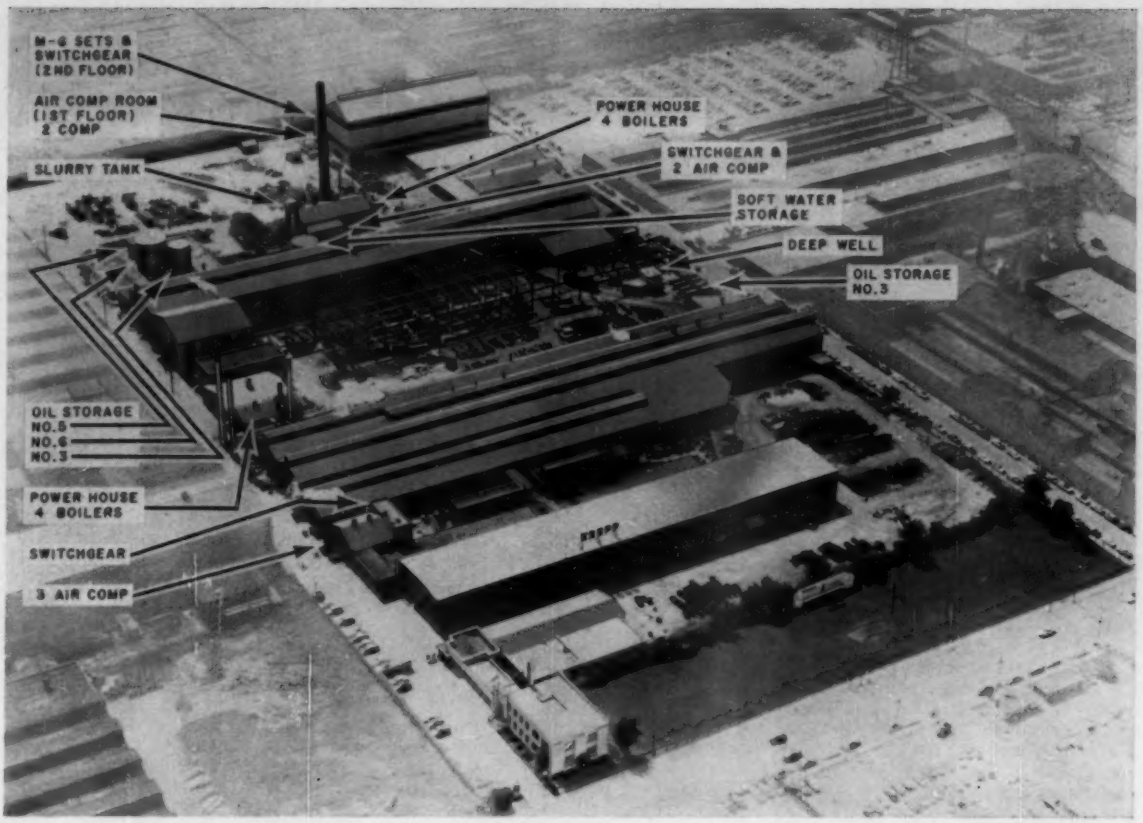


Fig. 1. Pattern of utility services that supports the operations of the big Kropp Forge plant in Chicago. Power department supplies and distributes oil, gas, water, electricity, compressed air and steam to the various sections of the plant

Kropp Forge's Power Department Meets a Complex Demand for Services

Job forging is characterized by a widely fluctuating need for oil, gas, water, electricity, air and steam. So, versatility and adaptability set the tempo for power department. Here's how it's done in one big shop

By FRED B. JACOBSON *

KROPP FORGE CO is a job forging shop. We do not make a product of our own, nor turn to producing stock items when business slows down. All work is scheduled on customers' orders. This means that demands on the power department can and do change suddenly from heavy demands on steam, electricity, air and fuel, to very light loads.

Also, the diversification of our forgings makes for continuous changes in our hammer schedules and the power needed to maintain them. Industries for which we make forgings include atomic energy, hooks and handling equipment, aviation and guided missiles, engine parts, struts, spars, landing gear. Road building, trucking, farm implements and heavy construction use many forgings, from tracks and shoes to beams and shafts. Railroads, also, use many forgings, especially for diesel engines, and marine work uses long shafts and other types of forgings, all of which we are able to make.

To do this work, we have 41 hammers ranging from 2000-lb board hammers to steam hammers at 35,000-lb and 50,000-lb falling weight. We also operate bulldozers and upsetters, and many forging and trimming presses. Our plant on W. Roosevelt Rd in Chicago is made up of a group of three forge shops and two machine shops, one of which is located about a mile from the main plant.

The power department supplies and distributes oil, gas, water, electricity, and air and steam to the various departments in the plant.

Steam is generated for hammer efficiency because the prime usage of steam is in the operation of the hammers. Other usages of steam, such as for the blowing of scale, are secondary. Automatic boiler controls take care of sudden load changes without noticeable pressure variations or water level changes in the boilers. This is important because of carryover, which would foul steam lines, hammer valves and traps.

Our boiler efficiency is high, but because of the size of the three hammer shops, and scheduling of hammers on the night shifts, there are times when only four to eight hammers are operating. This might mean one hammer operating in each of two shops, and the rest in the third shop.

* Chief Power Engineer, Kropp Forge Co

Fig. 2 (left). Prime use of steam is for the hammers, such as this 50,000-lb tool. Fig. 3, above, is view of die sinking and machine shop, facilities. They need plenty of compressed air

If all hammers operated in one shop, the remaining steam mains could of course be shut down. Hammer scheduling is done by the production department, and a list of hammer operations is forwarded to the departments concerned. This is done for each shift and covers the three forge shops.

There are eight boilers in the plant, in two boiler rooms, four boilers in each. The two boiler rooms are connected by a 10-in. steam line. We can generate 375,000-lb per hr dry saturated steam at 135 psi at the header, which is used mainly on the hammers. Some steam is used in the pickling rooms. The balance is used for space heating. Exhaust steam is used for the water softener and feedwater heaters.

Oil, Gas and Water

We use three grades of fuel oil in our various operations. No. 3 oil is used in the heat treatment department and also on some forging furnaces. No. 5 oil is used on all other forge furnaces, and No. 6 oil is used on boilers. We have three main oil tanks, and the various oils are unloaded directly from truck or car to these tanks and are then distributed by means of transfer pumps to other locations in the plant.

Eighteen fuel oil pumps are used in the pumping and unloading of the three grades of fuel oil. Ten fuel oil heaters are used in the heating of the oil and four tank suction heaters are used. Only the residual oil is heated.

Our oil storage capacity is 552,000 gallons. No. 3 oil tank holds 110,000 gallons, with an additional 24,000 gallons of storage capacity in our heat treatment department. No. 5 oil tanks holds 110,000 gallons, with an additional storage capacity of 48,000 gallons in our flat die department. No. 6 tank holds 252,000 gallons with an additional 8000-gal tank in our old shop boiler room.

Cylinder oil is pumped from the power plant to the various steam hammers for cylinder lubrication. This same oil poses a problem in the steam exhaust. The oil cannot enter the sewers, so we installed separators and made drainers for condensate, which dumps into a large tank. We then remove this oil from the water, centrifuge it, and return it to the cylinder oil tanks where it is reused.

We have two gas meter vaults. Each vault has two meters. One meter is for process gas, which is used the year-round on an interruptible basis, and one is for boiler gas, which is used from April 15 to Nov. 1. Oil is used on the boilers during the winter months. No coal is used in this plant. The interruptible gas means that for process use we can be curtailed 100 per cent. Anything other than "full use" (about 3,000,000 cu ft a day for process, not including boilers) is called an allotment.

It is up to the power department to distribute this gas for the best product usage in our plant. We have a form that is signed by the department supervisor, allotting his department gas where needed. These allotments are for 24 hours but may be increased or decreased at any time.

Two Sources of Water

Sources of water are two: city water from Lake Michigan and well water. The mains are interconnected on the two systems, but are valved off, so each system is isolated from the other unless we should suffer a loss from one of the sources.

Our deep well is capable of pumping 700 gpm. Normal usage is about 525 gpm of well water. This is used for process water in the plant. The well is 1638 ft deep, and the submersible pump is set 650 ft deep, with a 100-ft head of water over the pump. This water is pumped to a reservoir of 60,000-gal capacity.

The deep well pump motor is 175 hp and operates on 2300 volts. It pumps into the reservoir, and the water is then drawn from the reservoir by two 600-gpm pumps, one of which is in operation at all times; the other comes in automatically on an increased demand. We maintain a static pressure of 38 psi at the penthouse over the reservoir. The penthouse contains all of the controls, pumps and transformers.

There are three transformer stations in the plant, and a distribution center at each location. These transformer stations are owned and operated by Commonwealth Edison Co. Power is brought in at 2300 volts, stepped down to 480 volts, and distributed through our switchgear

Why This Article

It demonstrates clearly the vitally important place of the power engineer in one of our leading industries. His power department supplies a wide variety of steam and allied power services to production. It is a separate department; the author reports directly to the works manager. In this article he tells how he coöperates closely with the works manager, the plant engineer and the production departments in daily operation, in selecting new equipment, in planning and making changes and expansions.

Fig. 4. In expansion program, chief power engineer works closely with management on the selection of new equipment

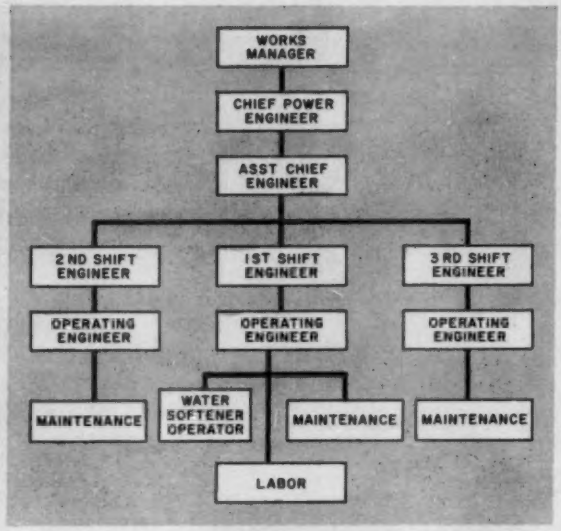


Fig. 5. Flow chart showing power department organization. Assistant chief is in charge of maintenance and repairs

to the various departments. We have a stepdown transformer from 480 to 240 for some of the older equipment which is used in our older shop, and this process is handled through a fourth distribution panel.

There are eight air compressors which range from 300 cfm to 756 cfm. All of these are motor driven. Three compressors are two-stage and five are single-stage. Four of the compressors have synchronous motors. Our boiler and hot process softener controls are actuated by compressed air. Many of the heater and softener controls are outdoors, so air driers were installed to preclude the freezing of controls.

A gasoline-driven portable unit of 250 cfm is used where compressed air is not readily available. Air has many uses in a forge shop and becomes an important product in a plant such as this one. Furnace doors are air-operated for fast operation. Air is used also for grinding and polishing of forgings, blowing scale and machining operations.

How We Expanded

During 1954 we undertook a major expansion program. Two 50,000-lb hammers and two forging presses were installed in a new plant building. This meant new electrical power sources, steam lines, water lines, gas, oil and air lines. It also meant the installation of a new boiler, a hot lime zeolite water softener, and two new air compressors.

Meetings to decide on equipment were held by the vice-president in charge of the program, and included the chief power engineer and the plant engineer. The power department and plant engineering worked very closely on this program, and it was a great satisfaction that almost all of our recommendations were used. The architects and consulting engineers were called in, and the program coördinated into a reality.

We had many problems, among them space, which is always at a premium. This meant that much power plant equipment had to be moved to make room for new.

No Work Shutdowns

During this time, our plant was in heavy production and we were not allowed a shutdown during the work week. Oil pumps and heaters, both oil and feedwater, were moved, and at times it was as though we were playing checkers. Feedwater heater lines, heaters and pumps were swung over on weekends, which made for a very tight schedule; but our planning paid off and we suffered no loss of production, although overtime ran high on many items.

A 1200-hp Babcock and Wilcox boiler was placed where we had had fuel oil pumps, heaters, sump pumps, and condensate pumps. An addition to the power plant was built to the east, to accommodate the water softener. Pumps and oil heaters were moved to the new basement.

This expansion set us up with the eight boilers mentioned above, which generate steam for the hammers and plant heating. The boilers are water tube, combination oil and gas fired, with steam atomizing oil burners using No. 6 fuel oil. Six units are three-drum, low head Titusville boilers; one is a three-drum Lasker boiler; one is a Babcock and Wilcox type FH, two-drum boiler.

Two of the Titusville units are 405-hp and 519-hp boilers. They are straight natural draft, manually fired, gas and oil. Four Titusville boilers are equipped with Republic Flow Meter instrumentation and are automatically fired on gas and oil. These boilers have forced-draft fans. The Lasker boiler is equipped with Republic Flow Meter instrumentation and has both forced and induced draft fans. The Babcock and Wilcox boiler also has Republic Flow Meter instrumentation, FD and ID fans, and an air preheater which enables us to boost over-all efficiency.

A hot lime zeolite softener of 192,000-pph capacity softens the feedwater for all of the boilers in service. Because of the large amount of steam generated on the day shift and lesser amounts used on the night shift, a 110,000-gal soft water storage tank was installed as a reservoir.

With this additional storage capacity we can maintain a recommended retention time in the slurry tank, and the softener is base loaded on a 24-hour operation. Our softener load does not fluctuate with the steam demand. The softener discharges into the storage tank, and the water is pumped from there to the feedwater heaters in both forge shop power plants.

Power Department Personnel

As chief power engineer, I am directly responsible to the works manager. The assistant chief power engineer is in charge of repairs and maintenance, while I take care of ordering supplies, including the three grades of fuel oils used in this plant. A daily and monthly inventory is kept of the use of water, gas, fuel oil and electricity, and as mentioned, we coördinate our steam generation with the production department's scheduling of the steam hammers.

Shift engineers are responsible both to the chief and assistant chief engineers, because much of our equipment is scattered in various locations of the plant, and this method seems to expedite matters. THE END

How to Select and Apply Strainers

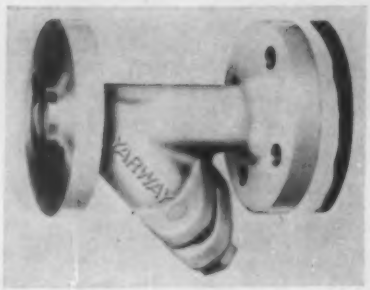


Fig. 1. High-pressure service strainer

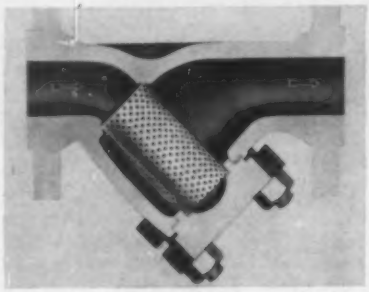


Fig. 2. Section of similar h-p strainer

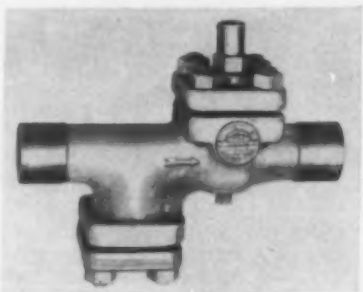


Fig. 3. Integral strainer protects trap

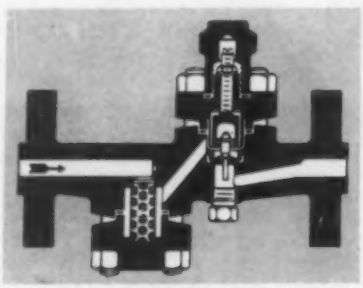


Fig. 4. Cross-section of the unit above

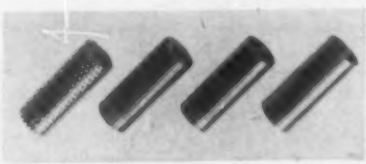


Fig. 5. Four special perforated screens

Here the author, in the second half of his article, discusses the pertinent aspects of the installation, operation and maintenance of all types of strainers, and describes construction details and materials employed. Special-purpose strainers are also discussed

By J. A. GEIGER*

EXCEPT FOR the bar-stock type, all the strainers discussed in the first part of this article are for low-to-medium-pressure service. Thus, the Y-type strainer is built for a maximum steam pressure of 600 psi and temperature of 1000 F. When handling cold liquids or gas, the maximum allowable non-shock pressure is 1440 psi. Table I shows typical maximum pressures and temperatures for screwed strainers. Socket-welding strainers of this design are available for higher pressures and temperatures.

For high-pressure service on steam and liquid lines, flanged or socket-weld strainers, Fig. 1 and 2, are commonly used. When choosing a strainer for high-pressure high-temperature service, particular care must be used in choosing the body and screen materials. Table II shows typical allowable pressure and temperature ranges for the flanged strainer in Fig. 1. Note how the materials of construction are changed as the pressure and temperature of the fluid increase.

Integral Strainers

Some steam traps and other equipment use integral strainers, Figs. 3 and 4. In this way an installation can be made more economical and also more compact.

The integral strainer as shown in Fig. 4 has a stainless-steel woven-wire screen with a protecting casing of perforated stainless steel, which is shown in Fig. 7. A bolted cover allows easy removal of the screen for cleaning. The cover can be tapped for a blow-off connection, if desired. These integral screens are used on traps for pressures as high as 2500 psi, temperatures to 1100 F.

Strainer Screens

Most important part of today's modern strainer is the screen. The reason for this is that one particle of scale, packing, welding dross, or dirt can cause serious damage to highly-engineered products manufactured to close clearances and tolerances. If you take the precaution to install a strainer, you should insist that the screen be durable, well-built, corrosion-resistant, and designed for the service in which it is used.

There are two principal types of screens used in modern strainers: punched or perforated, and woven. Each type has advantages for particular applications. Let's see what these are.

Table III summarizes the characteristics of perforated and Dutch-weave woven screens. Note that in all pipe sizes from ¼ in. through 2 in. the ratio of the screen open area to

* Yarnall-Waring Co

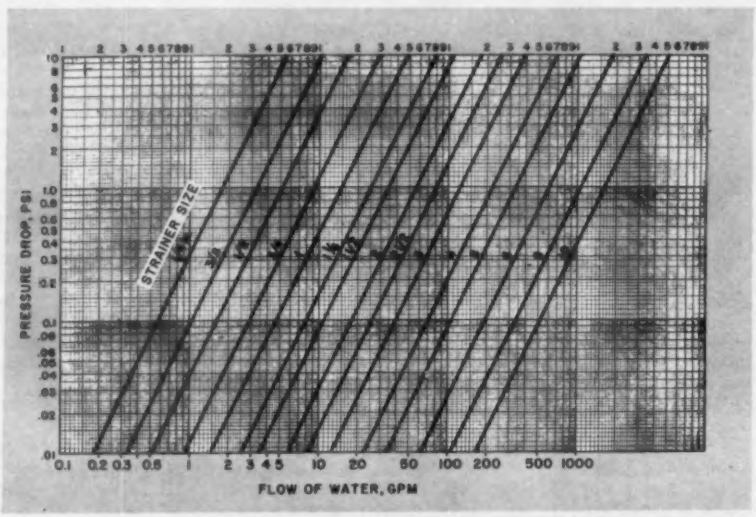


Fig. 6. Graph for the determination of pressure drop through various strainers

Why This Article

Every power engineer has strainers on his piping systems and equipment. They form vital protection for major and auxiliary equipment, to insure reliability of service. Here are basic data on their types and uses. This article is a review for old-timers, a must for young-timers.

the pipe inside area is greater for the Dutch weave than for the perforated screen. So in applications where maximum screen open area is a prime consideration, the Dutch-weave screen should be chosen.

In general, perforated screens are stronger than woven screens, and thus are used largely in high-pressure strainers like those in Fig. 1. Special perforated screens are available. Table IV summarizes their characteristics, and Fig. 5 shows four examples. The Dutch-weave screen finds its greatest use in low- and medium-pressure applications for strainers. However, woven screens are also used in high-pressure service with protective casings as shown in Fig. 7.

When selecting a screen you should know the minimum particle size the strainer must handle. A screen can then be chosen to prevent the passage of particles of this size, or larger. Figure 6 gives the approximate pressure drop through various size strainers. The exact pressure drop will vary with the screen opening size and the number of openings. For best results in choosing strainers, always follow the advice of the strainer manufacturer.

Strainer Materials

The most popular materials for woven strainer screens are Monel, stainless steel, and brass. Other materials available are steel, copper, bronze, nickel, aluminum, and Inconel. Perforated screens are commonly made of Monel or stainless steel. Bronze is popular in low- and medium-pressure applications.

Table I. Maximum pressure and temperature limits of certain screwed strainers

TYPE END	MATERIAL	STEAM		COLD LIQUIDS OR GAS
		Max Press. (lb)	Max Temp (F)	Shock Press. (lb)
Screwed	Cast Iron	250	410	400
Screwed	Bronze	300	425	500
Screwed	Cast Steel	600	800	1200
Screwed	Cast Stainless Steel	600	1000	1200
Socket Welding	Cast Steel	600	850	1440

Socket welding strainers are also available for higher pressures and temperatures.

Table II. Maximum pressures, temperatures for flanged and socket-weld strainers

TYPE END	MATERIAL	STEAM		COLD LIQUIDS OR GAS
		Max Press. (lb)	Max Temp (F)	Max Non-Shock Press. (lb)
Flanged	Cast Iron	125	350	175
Flanged	Cast Iron	250	410	400
Flanged	Cast Bronze	150	425	225
Flanged	Cast Bronze	250	425	400
Flanged	Cast Steel	150	500	230
Flanged	Cast Steel	300	800	600
Flanged	Cast Steel	600	800	1200
Socket Weld	Cast Chrome Moly WC6	1500	1000	3600
Socket Weld	Cast Chrome Moly WC9	1500	1050	3600

Table III. Important dimensions for various types and sizes of strainer screens

		DUTCH WEAVE				PERFORATED		
Size In.	ID Pipe In.	Dutch Weave Mesh	Approx Dia Largest Particle To Pass Thru Opening In Screen In.	Approx Ratio Of Screen Open Area To Inside Pipe Area	Equiv Market Grade Square Mesh	Dia Of Perf In.	Approx Ratio Of Screen Open Area To Inside Pipe Area	Equiv Market Grade Square Mesh
¼	0.364	12 x 64	0.008	11¾	60	0.020	6½	40
⅜	0.493	12 x 64	0.008	6¼	60	0.020	3½	40
½	0.622	12 x 64	0.008	5½	60	0.020	3	40
¾	0.824	12 x 64	0.008	4¼	60	0.020	2½	40
1	1.049	12 x 64	0.008	4	60	0.020	2¼	40
1¼	1.380	10 x 52	0.010	3¼	50	0.020	2	40
1½	1.610	10 x 52	0.010	3½	50	0.020	2	40
2	2.067	10 x 52	0.010	3¼	50	0.020	2	40
2½	2.469	14 x 40	0.012	3	45	0.045	3¼	16
3	3.068	14 x 40	0.012	2¾	45	0.045	3	16

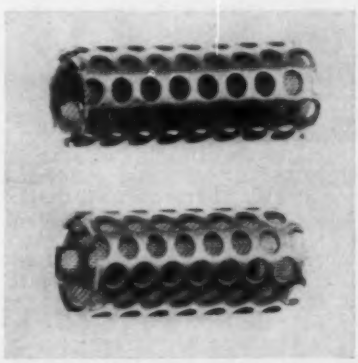


Fig. 7. Screens with protective casings

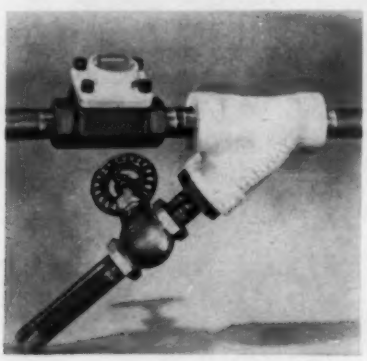


Fig. 8. Y-type strainer with blow-off

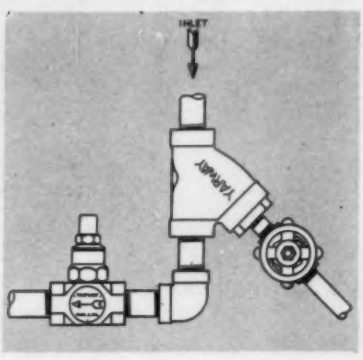


Fig. 9. Easily-cleaned vertical Y-type

Table IV. Dimensions applicable to different types of special strainer screens

Size In.	ID Pipe In.	½-IN. PERFORATED: Approx Ratio Of Screen Open Area To Inside Pipe Area	½-IN. PERFORATED: Equiv Market Grade Square Mesh	.045-IN. PERFORATED: Approx Ratio Of Screen Open Area To Inside Pipe Area	.045-IN. PERFORATED: Equiv Market Grade Square Mesh	⅛-IN. PERFORATED: Approx Ratio Of Screen Open Area To Inside Pipe Area	⅛-IN. PERFORATED: Equiv Market Grade Square Mesh
¼	0.364	9½	20	12	16	10½	10
⅜	0.493	5	20	6½	16	5¾	10
½	0.622	4¼	20	5	16	4¾	10
¾	0.824	3½	20	4½	16	4	10
1	1.049	3¼	20	4	16	3½	10
1¼	1.380	2½	20	3½	16	3	10
1½	1.610	2¾	20	3¾	16	3¼	10
2	2.067	2¾	20	3½	16	3	10
2½	2.469	2½	20				
3	3.068	2¼	20				

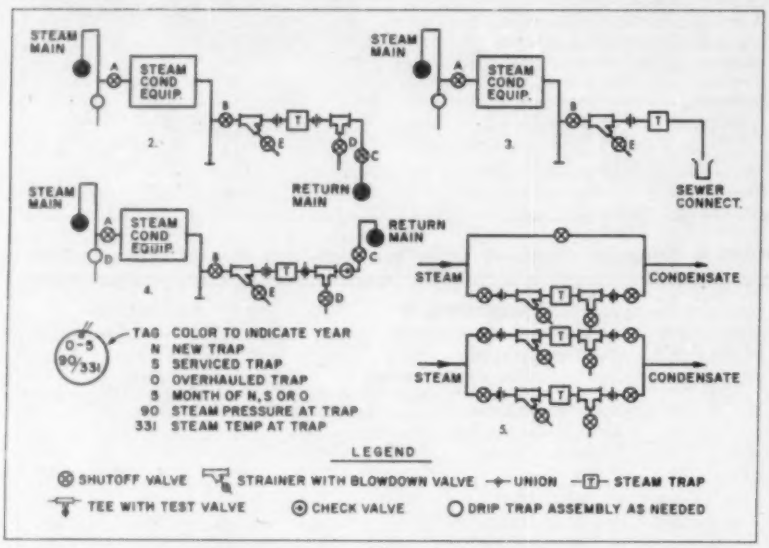


Fig. 10. Typical installations of strainers protecting traps and other equipment

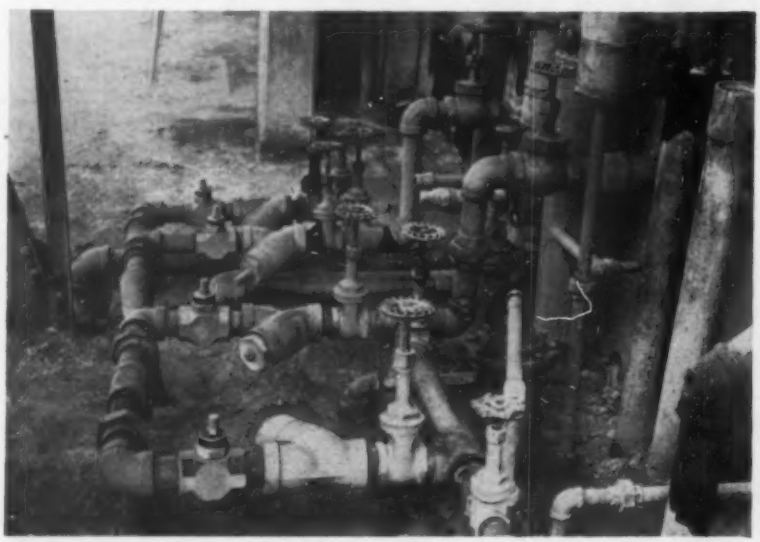


Fig. 11. When freezing is a problem, horizontal blow-off changer should be used

Modern piping practice recommends installation of a reliable strainer ahead of every piece of pipe-line equipment that may be damaged or made inoperative by the accumulation of dirt, chips, scale, or other foreign matter.

Figure 8 shows a Y-type strainer connected into a horizontal line ahead of a steam trap. This type of strainer is installed in the same way when used to protect a reducing valve, controller, or other device. A Y-type strainer can also be installed in a vertical position, as in Fig. 9, so the dirt collects inside the screen from where it can readily be blown out through the blow-off fittings.

Five different trap installations using strainers are shown in Fig. 10. Note that each trap has its own strainer. Use of a separate strainer for each unit is recommended by all trap, valve, and control manufacturers.

Where there is a chance of liquid freezing in a Y-type strainer, install the unit so the blow-off is horizontal, Fig. 11. With the strainer in the position shown, the liquid will not completely fill the screen chamber during shut-down.

To allow easy cleaning of the screen whenever dirt accumulates in it, connect a permanent blow-off line fitted with a valve or shut-off cock to the strainer, Fig. 8.

T, S and other strainers have special installation requirements. In general, these resemble the recommendations for Y-type strainers, except that the T and S strainers should not be installed in a horizontal position. Consult the strainer manufacturer.

If the steam trap or other devices served by the strainer begin to act sluggishly, the cause of the trouble may be clogging of the strainer screen. Blowing down of the strainer by opening the blow-off valve will frequently remove the accumulated debris from the screen. When difficult dirt and scale conditions make more thorough cleaning necessary, the pressure must be shut off and the screen removed.

To remove the screen, unscrew the cap or loosen the blow-off cover bolts. The screen should come out with the cap or cover. If a spare screen is available, insert it in the cap immediately, after carefully checking to see that the gasket is in good condition. Screw the cap up against the gasket, or tighten the flange bolts. Make a tight seal, but do not use excessive force.

Strainers are valuable safeguards in every modern industrial and commercial plant. The inexpensive strainer usually protects equipment having a large purchase and operating cost. So correct strainer selection and application is extremely important to all engineers and plant operators. By using the hints given in this article, and working with strainer manufacturers, you will get better protection from every strainer. THE END

Bureau of Mines Comments on Underground Gasification

Says British work has been abandoned, Russian work not as good as claimed. U. S. costs too high to be competitive in foreseeable future; on limited budget, Bureau must work on more attractive short-range projects. Hence, U. S. underground gasification program suspended

FOLLOWING is the complete text of a letter just received, signed by Royce A. Hardy, Assistant Secretary of the Interior.

"Department of the Interior has noted the article and your editorial on *Underground Gasification . . . Is U. S. Second Best?*, May 1959 issue, POWER ENGINEERING. It is gratifying that a publication of such stature should direct its attention to the problem of coal research and the Bureau of Mines program in this field. Here are the factors that led to the suspension of our underground gasification tests.

Techniques Abroad

"Throughout our program at Gorgas, we have followed closely the technologic developments abroad, particularly in the USSR and Great Britain. Economic conditions and fuel resources in these countries differ greatly from ours, permitting them to mine coal beds that would be considered uneconomic in the U. S.; and both those countries have made a concerted effort to develop a practicable process for the underground gasification of coal. As you probably have learned since the publication of your article, it is reported that the British have also abandoned their efforts and are withdrawing from the underground gasification program.

"In your article, you have stated that gas production in the USSR amounts to 'billions of cubic meters annually.' Russian estimates vary, of course, but I believe that this estimate is quite unrealistic. Russian engineers associated with the underground gasification program have reported that gas production in 1956 totaled 617 million cubic meters, with more than 400 million cubic meters being produced at the Podmoscow station alone. The actual significance and the desirability of continuing the underground gasification experiments in the USSR has been the subject of a great deal of debate and controversy in Russia itself.

"Z. F. Chukanov, a noted expert on underground gasification, concluded that underground gasification is unprofitable, productivity poor, and scientific work on the process development unsatisfactory. In the *Bulletin of the Academy of Sciences* (*Vestnik AN*, No. 8, 1958), he indicated that the Lisichansk station is unable to cover even its own requirements in electric power from the gas produced and needs annually about 7,000 tons of Donetz coal mined in the usual way. He also states that in some districts, as in the Moscow region, the Podzemnaya Gazifikatsiya Ugley stations obtain cheap electric power for running their plants from the electric mains (Mosenergo), as this is much more economical than using some of their own gas.

"Afendikov and Buyalov suggested that new industrial underground gasifications stations should not be begun until an economically advantageous underground gasification process which can be controlled has been found, since, with things as they are at present, the operation of such stations will be completely unprofitable. M. Stirikovich and other Russian engineers have pointed out that gas must be used in the immediate vicinity of the place where it is produced, as it is so poor that it is not worth transporting over any considerable distance.

Bureau's Studies

"The Bureau's findings reflect many of these criticisms of the Russian program. The data acquired throughout the Bureau of Mines — Alabama Power Co experiments at Gorgas were evaluated, and indicated that the cost of energy produced by underground gasification far exceeds the cost involved in conventional coal mining and processing. You are correct in pointing out that the greatest technologic potential of this process is in the gasification of lignite. However, apart from other considerations, the location of our lignite deposits is such that a large market for the gas produced would not be available at this time, and probably not for some time in the future.

Decision to Suspend

"In the face of these problems, the desirability of continuing the underground gasification program was carefully considered. The Bureau's research budget is, of course, limited. The recent congressional hearings on coal research and development in the industry have emphasized the need for more research on short-range applied projects. On the basis of these and other factors — consistent results showing unfavorable economics, the lack of new suggestions to investigate that offered economic promise, the availability to us in English of the extensive results of Russian and English experiments, the need for additional research in other areas, and the limited funds available — a meeting of the Director's Underground Gasification Advisory Committee was called and the findings were presented and discussed.

"The consensus of this committee was that the process costs were too high to permit effective application of this technique in the U. S. in the foreseeable future, and no promising new direction could be given to the program that would narrow this gap between the economically feasible and our actual operating experience. For these reasons and those mentioned above, a decision was made to suspend the underground gasification program.

"As you know, the underground gasification program represented only one of the Bureau's attempts to conserve our national coal reserves and to develop a technique for better utilization of all types of reserves. Other Bureau investigations are concerned with this same problem, but approach it from a different standpoint. It is hoped that some of these techniques currently being explored, and those that will be explored in the near future, will produce results that are more in line with immediate requirements and possibilities. THE END

Why This Article

IN THE May issue, pages 66 to 68, the editors of POWER ENGINEERING reviewed the underground coal gasification programs of Great Britain and the USSR and the work by the Bureau of Mines and Alabama Power Co at Gorgas. The latter has been beset by budget troubles and is now at a standstill. We urged its resumption with more adequate support.

Now, Royce A. Hardy, Assistant Secretary of the Interior, tells us why the program at Gorgas was suspended. Because of the relation of this subject to the problems of the nation's fuel resources, we feel readers should know his reasons.

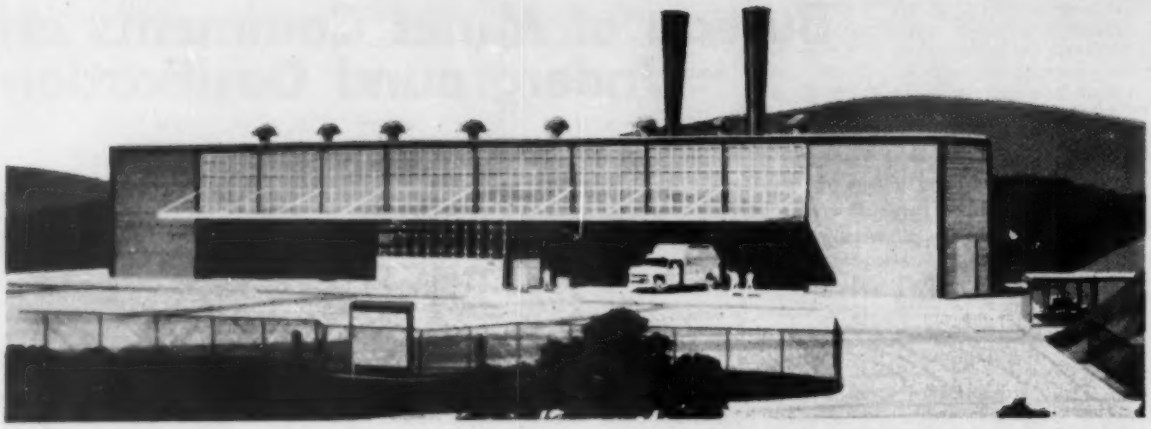


Fig. 1. Philadelphia's new Northwest incinerator plant has the modern look. Fly ash eliminators and ID fans make possible short tapered stacks. The two 300-ton furnaces each have traveling grate stokers. Feeding and discharge are continuous

The Big Waste Burning Plants Are A Source of Heat and Power

Engineered disposal of solid waste is fast becoming big business, and utilizing the heat generated is proving to be good business, too, in many a recent installation. This article is the first in a group on solid waste incineration practice as it is carried out today

By JOHN H. D. BLANKE*

TWO MAJOR METHODS are used for disposal of solid community waste — incineration and sanitary landfill. Incineration is a process for reducing solid waste by combustion to an inert residue of 5 to 10 per cent of the original volume. Including all municipalities down to a population of 5000, approximately 17 per cent of the communities incinerate. However, when considering only all municipalities above 100,000 population, the incinerating communities range from about 56 to 100 per cent, depending on population grouping. Need for incineration increases with the size of the municipality; this is due to the increased volume of solid waste and difficulty of obtaining sites for sanitary landfill or other disposal method.

Community solid waste incinerators are operated in nearly 500 American municipalities. Many of the larger cities operate two or more incinerators, the largest ones having installed six to a dozen plants.

Distribution of community solid waste incinerators in American cities down to a population of 5000 is indicated in the table (right), compiled from sources derived in 1958.

Significant progress has been made in the now-closing decade in expanding the use of engineered incinerators and improving the techniques for disposal of solid community waste. New York City started early in the 1950's to modernize or construct about a dozen incinerator plants in an $80,000,000 solid waste disposal improvement program.

Chicago has launched an ambitious program of constructing four community incincerators which include the now-operating 720-ton Medill plant. There are three additional plants, each of 1200 tons capacity. Philadelphia's $22,000,000 solid waste disposal improvement program envisions 4950 tons of incinerating capacity by the year 1970, distributed in nine plants. Baltimore operates four incinerator plants having a combined plant capacity of 2400 tons.

Plants in 438 Cities

Considering that all of the million-plus cities, nearly all of the medium-sized cities and some smaller cities have more than one solid waste incinerating plant, it is apparent that approximately 500 plants are involved in the 438 indicated incinerating municipalities of 5000 and more.

Population Group	No. of Municipalities		
	Total	Incinerating	% Incinerating
Above 1,000,000	5	5	100%
500,000–1,000,000	13	11	84.6%
250,000–500,000	23	13	56.5%
100,000–250,000	68	40	58.8%
50,000–100,000	135	51	37.7%
25,000–50,000	292	76	26.0%
10,000–25,000	858	132	15.6%
5,000–10,000	1181	110	9.2%
Total	2565	438	17 %

A leading manufacturer of incinerator stokers of the rocking grate type has recorded 56 orders, 13 of them repeats, for the period of 1953 to 1958, inclusive. This includes a total of 121 stokers and a total plant design capacity of 16,131 tons per day. Plant capacities range from 35 to 1200 tons and the stoker capacities from 35 to 425 tons. Another leading manufacturer of incinerator stokers has reported 76 installations for the period of 1946 to 1958, inclusive, a number of them in Canada, with a total capacity of 19,364 tons.

Factors entering into the design of community solid waste incinerators include quantity of waste to be collected from a given area; general composition of the waste, its moisture content, heat content and combustion residue; distribution of the waste in the service area; residential, commercial and industrial sources of the waste; daily peak load of collector vehicles; required time of incinerator operation in hours per day and in days per week; and the relation of the proposed incinerator site to the surrounding area as regards general topography, structures, atmospheric conditions and legal plus other community standards.

Three types of solid waste are gen-

*Technical writer. Member of Western Society of Engineers

erally disposed in community incinerators. These are identified broadly by standards of The Incinerator Institute of America, as, 1. rubbish, 2. refuse, and 3. garbage. Moisture content of the first is up to 25 per cent; up to 50 per cent for refuse; up to 70 per cent for garbage.

Moisture content and other characteristics of community waste are affected by collection procedures, climate, and heating habits of the area served. Extensive use of garbage grinders in a community significantly reduces the moisture content of waste collected for incineration. The proportionate increase in heat content of the waste, on a weight basis, may obviate the need of auxiliary gas or oil fuel that may normally be required for incineration of refuse to support the combustion process. The possibilities for recovery of waste heat would be improved.

By chemical analysis, the typical American refuse is rather uniform to its close relatives, wood and bagasse. When including the water and ash content of collected community waste, the fuel value per pound may be only 2500 to 6000 Btu. However, on a moisture-free basis and ash-free basis, the fuel value may range from 8000 to 10,000 Btu, with 9000 Btu considered satisfactory for incinerator design purposes.

Moisture content of refuse or waste today is much lower than it was even a decade ago. Content of garbage of high moisture has been decreasing, due to the increasing use of packaged and frozen prepared foods, and due to the increasing use of garbage grinders. Cartons, paper sacks, crates, and similar easily burnable materials make up the major portion of waste. Fuel for community incinerators is becoming a better combustible. Its principal constituents, free of moisture and inert residues, and their content in Btu per lb are: wood, 8240; brush, 8600; paper, 7900; garbage, 7280; and the average calorific content is 8050 Btu per lb.

Really a Power Plant

One to two pounds of steam can be produced from a pound of average waste. Heat generated by incinerating solid waste may be utilized in various applications, depending on plant design and location. It may be used to heat water for the scrubbing of plant facilities and waste collection vehicles. It may be used also for personnel sanitation and to heat building spaces.

In larger incinerator plants, heat from waste may be utilized in boilers to raise steam for turning turbines that drive electric generators, deep well pumps, and other plant machinery. Waste heat boilers may be equipped with gas or oil burners to provide standby heat for continued operation at full load. Turbines may exhaust to plant processing and heating systems. Surplus steam may be dispensed to district heating systems or to a nearby steam central station.

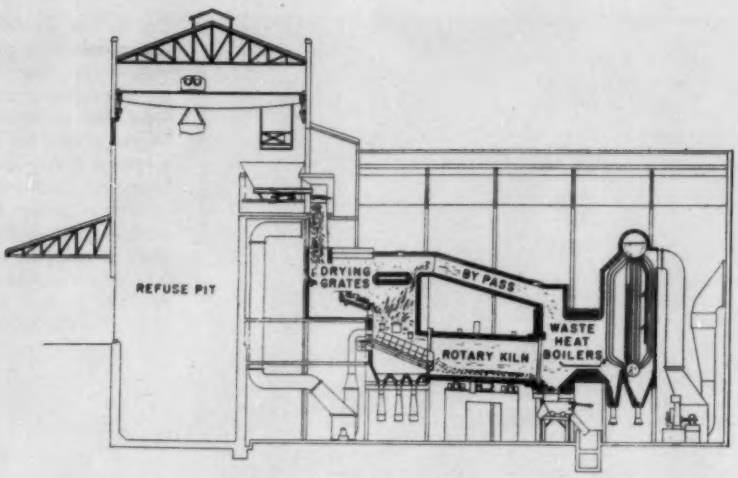


Fig. 2. Municipal incinerator in Atlanta is designed to utilize waste heat from refuse burning for making steam in waste heat boilers. Plant is of the Volund design developed in Europe. Note circulation of refuse and gases, and novel kiln

Fig. 3. Operating floor of the 300-ton incinerator at New Britain, Conn. Ignition chambers of the circular destructors are fitted with coned rotating arm stokers. Gases pass from furnace to combustion chamber (rear). Note control panel

Hot water and steam produced from incinerating solid waste may be stored in accumulators for extended use.

The community solid waste incinerator is, in effect, a heat-generating industrial plant. It consists essentially of a refuse storage pit with facilities for charging the furnace; a chamber or furnace for drying and igniting the fuel; a combustion chamber for burning the released gases and solids; an expansion chamber with facilities for removing dust from flue gases; a boiler plant for recovery of waste heat of combustion, if desired; an ash removal system with scrap metal salvage; a choice of various types of grates and mechanical stokers; a selection of instruments for indication and control of combustion procedure, plus all sorts of auxiliaries for refinement of the entire plant, including fans, blowers, fire protection, vacuum cleaning system, alarms and supervisory communication facilities. (Incinerators at Atlanta, Ga, and Louisville, Ky, designed after the European Volund incinerating process, have a rotating kiln-type furnace in place of the customary combustion and expansion chambers.)

Typical heat value design for a 100-ton per day (24 hr) refuse incinerator equipped with the latest improvements, which include continuous feeding of refuse and continuous discharge of the ash and other inert residues, may comply with the following specifications: 100 tons of refuse burned in 24 hours; 8340 lb of refuse burned per hour; 41,700,000 Btu released per hour; 139.6 sq ft of grate surface; 2080 cu ft of furnace volume; 10,200 cu ft of forced draft per

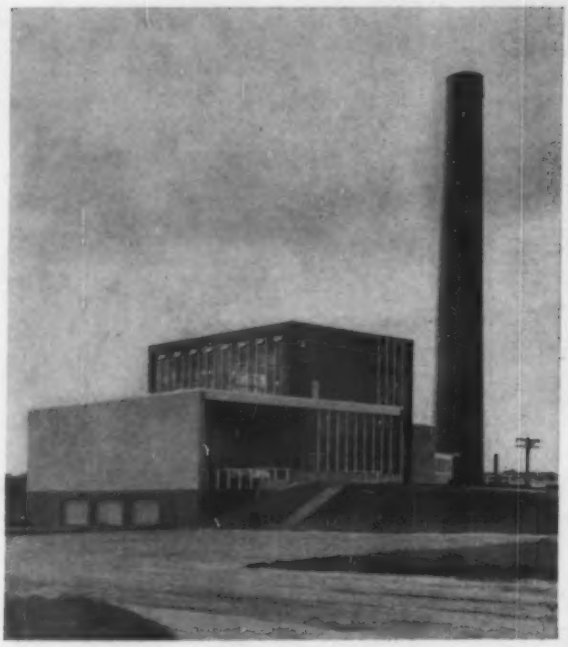


Fig. 4. 350-ton incinerator at West Hartford, Conn, was placed in service in 1958. Plant has forced draft, water-quenching ash disposal, central vacuum cleaning system, and expansion chambers with dry baffle walls for fly ash control

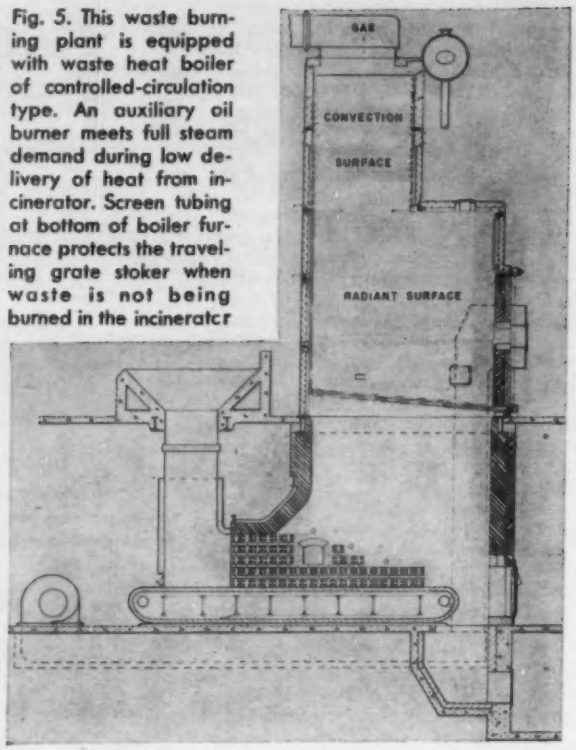


Fig. 5. This waste burning plant is equipped with waste heat boiler of controlled-circulation type. An auxiliary oil burner meets full steam demand during low delivery of heat from incinerator. Screen tubing at bottom of boiler furnace protects the traveling grate stoker when waste is not being burned in the incinerator

minute; 59,400 lb of gas per hour at the furnace outlet; 60,300 cu ft of gas at 2000 F; and 60.3 sq ft of flue area at 1000 ft velocity per minute.

New York City designs its incinerator capacity on the basis of 3.2 lb of refuse per person per day, which is 1168 lb or 0.58 ton per person per year.

How the Heat Is Being Used

Here are a few examples:

The 150-ton incinerator at Cheektowaga, N. Y., has a waste heat boiler in which the hot flue gases are utilized to heat water for a thermostatically controlled building heating system. The gases are drawn through the boiler from the main flue of the incinerator furnace and then returned to the flue by use of a suction fan. The heated water circulates through unit heaters located about the building and garage. When the incinerator is shut down, the office and the men's locker room are heated by an auxiliary oil- or gas-fired boiler connected to the same heating system, but to supply only sufficient heat to prevent freeze-up of the piping on the incinerator floor and in the garage. The auxiliary boiler also supplies heat deficiencies that may occur during incinerator operation.

The community incinerator at Oyster Bay, N. Y., rated 500 tons per day and sectioned in four 125-ton furnaces, passes waste heat to two Stirling H-type boilers, each capable of raising 13,000 lb of steam per hour at 250-lb pressure. The steam, delivered to a 400-kw turbine generator, more than suffices the needs of the incinerator plant, including a 60-hp 500-gpm deep well pump, and of adjacent proposed other municipal buildings. Turbine operates a 5-lb back pressure and its exhaust is used to heat the buildings and to precipitate flash in flue passages to the chimney. A 400-kw diesel-electric generator is installed as a power standby.

The 900-ton municipal incinerator at Miami, Fla, sectioned into six 150-ton furnace units, ranks among the most modern in the country. It is said to have the largest steam-generating system for the utilization of waste incinerator heat in use today. There are four Erie City vertical bent-tube waste heat boilers, each rated at 26,800 lb of steam per hour. All auxiliary boiler plant equipment, including boiler feed pumps, induced-draft fans, well pumps, furnace charging gates, etc, are powered with steam from waste heat.

Generating at 240-lb pressure, the Miami plant produces on the average about 1,500,000 lb of steam per day (its 24-hr per day capacity is about 2,500,000 lb). The steam, except for about 200,000 lb required by boiler plant auxiliaries, supplies the needs of a modern 1200-bed hospital, a medical section of the University of Miami, also the Dade County blood bank, the steam turbine pumping station of Miami's water department with capacity of 22,000,000 gpd, and the city's garage and truck cleaning facilities.

The city of Atlanta, Ga, built its first steam-producing incinerator in 1913 when its population was 155,000. Steam production expanded as the city grew. In 1925, plans were launched to sell incinerator-produced steam to the local power company. Two years later a new incinerator plant was completed. During 1939 the city searched for ideas for a more efficient and larger incinerator plant. The Volund principle of incineration was adapted for design and the new plant completed in 1941. It has a refuse incinerating capacity of 330 tons in 24 hours, sectioned in two 165-ton furnaces. An additional plant, similar in design and of 350-ton capacity, sectioned in two 175-ton furnaces, is to be completed this year.

Fans Carry Gases to Boilers

Forced- and induced-draft fans carry the hot gases from the incinerator furnaces and rotary kilns to two-drum bent-tube waste heat boilers. Each furnace has its own boiler which generates steam at 175 lb (1941 installation). Most of the produced steam is sold to the Georgia Power Co and is passed through reducing valves to 150-lb pressure mains. Remaining steam (about 15 per cent of steam boiler output) is used principally to operate two vertical single-cylinder 60-hp engines that drive the ID fans, and to turn a turbine-driven centrifugal boiler feed pump. Exhaust steam serves the feedwater heater and the incinerator plant's hot water system.

Community-type of engineered incinerator finds a commendable application in various major industria

plants, hospitals and other institutional buildings. To illustrate the trend in this direction, the following list is given from the records of a manufacturer of rocking grate stokers. Indicated are the year of order, design capacity of the incinerator plant and the number of stokers, if more than one:

Industrial Incinerators

Dodge main plant, Detroit, Mich, 1950, 200 tons, 2 stokers; Lincoln-Mercury Division, Wayne, Mich, 1952, 71 tons; Ternstedt Division, General Motors, Flint, Mich, 1955, 72 tons; Ford Motor Co, Sterling Township, Mich, 1956, 60 tons; General Motors Corp, Warren, Mich, 1956, 144 tons, 2 stokers; Chevrolet Division, General Motors, Janesville, Wis, 1956, 120 tons.

Hospitals and others: Montefiore Hospital, Bronx, N. Y., 1957, 30 sq ft; Beth Israel Hospital, New York, N. Y., 1958, 25 sq ft; National Institute of Health, Bethesda, Md, 1952, 145 tons, 2 stokers; Lawrence Hanscom A.F.B., Bedford, Mass, 1957, 50 tons; Offutt Air Force Base, Omaha, Neb, 1958, 37½ sq ft.

In industrial or institutional service, waste incineration affords an opportunity to combine its operation and maintenance with that of heating, processing or power plant on the premises. In fact, possibilities exist where the heat generated in burning waste can be delivered to the boiler system used in raising hot water or steam for heating, processing and power generation. Where the cost of customary fuels is relatively high, such utilization of waste heat is recommended. The practice has proved acceptable in plants in European countries.

Industrial wastes of high Btu value and of high combustibility need to be burned under special caution to protect incinerator refractory against excessive temperatures and against abnormal temperature variations. Use of an auxiliary oil or gas burner becomes advisable as an aid in maintaining furnace temperature during a slack or shutdown of waste burning. Such a provision makes it desirable, too, to operate the incinerator in conjunction with the boiler plant.

Relatively small incinerators and the various kinds and sizes of prefabricated incinerators may be able to produce only enough waste heat to supply incinerator plant use such as steam for powering auxiliaries, or hot water for heating and sanitation.

Many of the modern community incinerators have facilities and instruments that permit centralized supervision of plant operations from an advantageous standpoint. At Oyster Bay, N. Y., for example, signal lights on the control board show what parts of the plant are ready for operation, what parts are in operation, and the performance of each operating part. A pH indicator shows the condition of the ash-quenching water. Other instruments show and record steam pressure, draft, temperature of furnace, weather conditions, smoke density, and other conditions that must be known to the plant superintendent.

Centralized control installed at the 900-ton incinerator in Miami, Fla, affords the plant superintendent instant supervision over all plant operations. He has before him in the office visual registering and recording instruments for every need. He can control the feeding of refuse to each furnace, regulate the refuse burning rate separately in each furnace, adjust each forced draft fan to suit burning requirements, and regulate delivery of hot waste gases from the incinerator combustion chamber to the waste heat boilers for making steam.

Many of the smaller community incinerators have voice communication systems for controlling plant operations. THE END

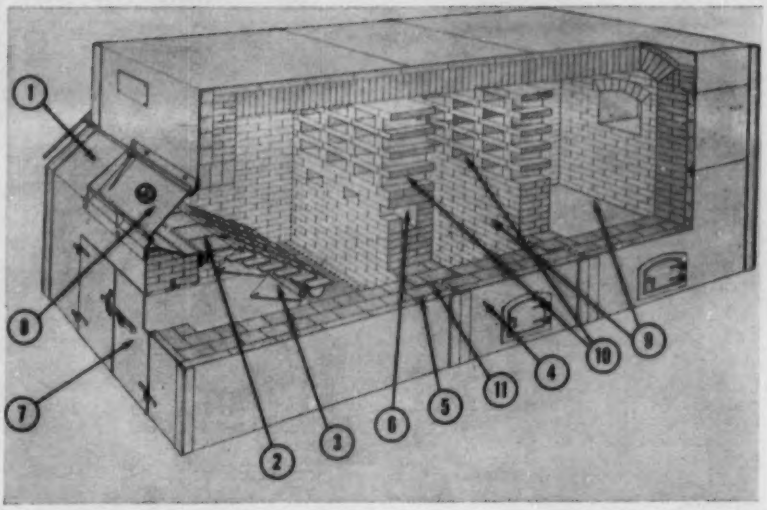


Fig. 6. Step grate incinerator for industrial use: 1. inclined front charging gate; 2. bar-type step grate; 3. free sliding sectional ash grate; 4. steel casing; 5. block insulation; 6. adjustable secondary air openings; 7. ash pit doors; 8. inclined door and frame; 9. two-stage secondary combustion chamber; 10. firebrick checkerwork pattern; 11. firebrick lining of standard shapes

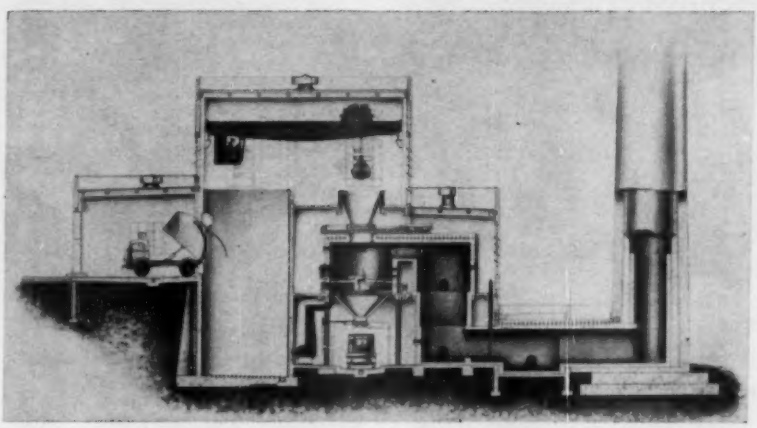


Fig. 7. Engineered incinerator designed with vertical circular furnace charged by crane from top. Refuse is burned on rotating arm stoker. Ashes are discharged to truck and combustion gases delivered to chamber adjoining stoker furnace. Note flue passages, chimney and refuse pit storage facilities. Revolving cone and rotating arms of stoker raise and lower gently, agitate fuel and move burning mass

Figures courtesy of Combustion Engineering, 1 and 5; *Southern Power and Industry*, 2; Morse-Boulger Destructor Co, 3; Nichols Engineering and Research Corp, 4 and 7; Joseph Goder, Inc, 7.

Want extra copies of these articles on modern incineration practice? Write The Editor, POWER ENGINEERING, or jot down Incinerators on return postcard inserted elsewhere in this issue.

Inflatable Metal Tubing Comes to Town

Experimental production is being started this fall of light-wall seamless metal tubing that can be shipped in ribbon form and inflated at point of use. Versatile new material is called Strubing

Fig. 1. First step in production of Strubing. Starting base tube or other hollow shape is passed through mill

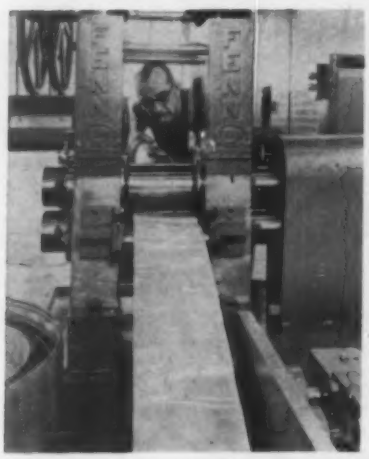


Fig. 2. Rolling process is repeated, elongates starting shape by making it thinner without changing inside diam

STRIP TUBING, called Strubing by its manufacturer, is on the verge of availability and holds promise of major innovation in many industries, including electric power distribution, construction and communications.

Strubing offers two major advantages. First, point-of-use inflatability makes it possible to ship thin-wall tubing economically, since only the tube walls are shipped and not the hole. Second, the process used in making the tubing, technically classified as cold rolling, is an economical way of producing thin-wall tubing of materials and in thicknesses either unavailable today or available only at a prohibitive cost.

Field inflatability might make it possible, for instance, to ship the entire ductwork for the heating system for a seven-room house in a box the size of an orange crate instead of in trailer-truck loads. The Strubing "ribbon" might be strung through the house and then inflated right in place.

Because of its availability in long lengths and very light walls, Strubing could simplify the problems of sheathing power distribution and communications cable.

Lining-by-inflation techniques might combine Strubing made of a corrosion-resistant material such as tantalum and ordinary steel. Tantalum Strubing ribbon would, for example, be inserted in a pipe or tank and inflated to form an inner liner.

Typical uses for small-diameter Strubing might be for instrument lines, or automotive tubing such as radiator, overflow, and thermostatic control lines.

Methods and equipment to be used for inflating Strubing will vary with the application of the material and its dimensions. Hydraulic pressure, air pressure, and mechanical means have all been used. The thinner the wall thickness, the lower the pressure required for inflation. Shipment of the material is expected to be in coil lengths of as much as 15,000 feet.

First step in producing Strubing is to make a simple hollow shape by conventional techniques. The shape is then passed through a rolling mill in which it is flattened into ribbon form. The more this passes through the rolls, the thinner the Strubing. Diameter is limited only by the size of the starting piece, and the size of the starting piece is limited only by the capacity of the rolling mill used. Inherent in the rolling process is a pair of fins or ribs on the outside of the material. These fins give added stiffness but can be removed if desired.

For more information about this new product, write The Editor of POWER ENGINEERING, or jot Strubing on the post card inserted in this issue.

THE END

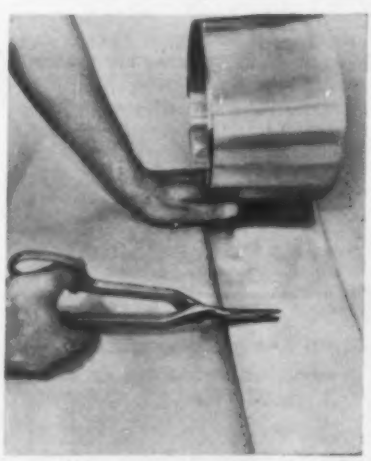


Fig. 3. On the job, roll of Strubing provides whatever lengths are needed. Desired length is cut with metal shears

Fig. 4. Strubing is then inflated, in this case with water. Air pressure and mechanical means are also used for this

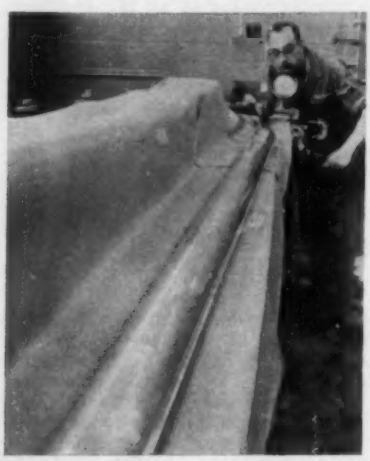


Fig. 5. Strubing can be made in sizes ranging from smaller than pencil lead to pipe big enough to walk through

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Power Engineering handbook

Make Your Own Coupling Guard and Spray Shield

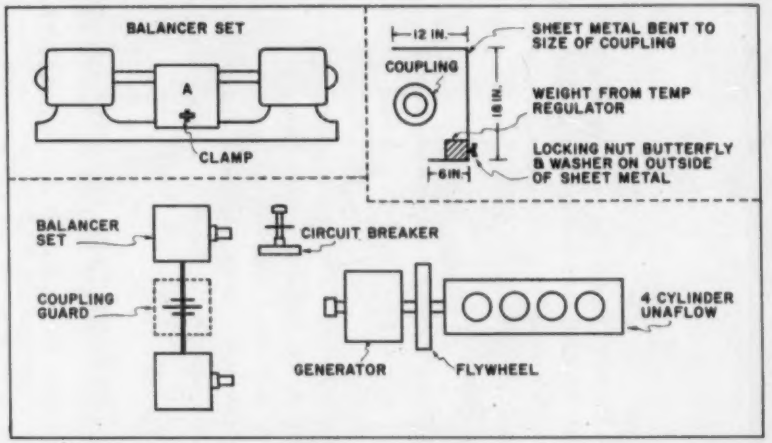
By JOHN KING

HERE's one for the power engineer's Handbook. It's simple and easy to make.

A balancer set with a flexible coupling posed a triple threat: 1. it was low, and ran so smoothly you forgot it was running, and had an exposed coupling that could catch hands, sleeves, flashlights, etc; 2. it was worn, and threw a fine oil mist on the floor and into the generator of No. 2 Unaflo engine; 3. funds were tight — no money available for repairs or replacements.

The problem was complicated by the fact that engines, generators, switchboards and circuit breakers were all poorly located for operation, maintenance, and cleaning. This plant had been built in the 1890's and as the load grew, more machinery was simply crammed into the same floor space.

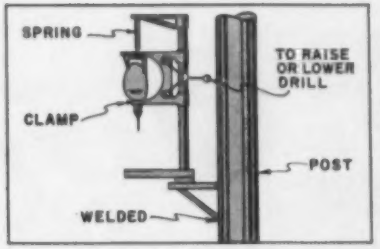
The operating engineers came up with a combination coupling guard and spray shield made out of sheet metal and a weight from a hot water heater temperature control, as shown in the sketches. It may be painted a bright color, is easily portable, and when the balancer is not in use, will come in handy as an obstacle over open manholes to pipe spaces, etc.



Coupling guard A can be quickly made from sheet metal, bent and pierced with hole for weight clamp

fold along this line—outside edges toward you

Handy Drill for Power Plant Work



By JAMES M. CURRAN

SKETCH shows a tool that has proved its value in our power department workshop at St. Raymond Paper, Ltd, in Desbiens, Quebec. It's an electric drill rigidly attached to a post in the shop. The three knobbed levers are for lowering or raising the drill, as required. When necessary, the drill can be taken off, by loosening the clamps at the top and bottom of the drill.

Glass Drilling Made Easy With Carbide Drill

By PAUL C. ZIEMKE

DRILLING GLASS has been a chore the average mechanic has shied away from because of the risk of ruining some expensive glass. As might be expected, with carbide-tipped tools being used more and more widely in industry, a tipped drill is now available for the tricky job of drilling perfect holes in glass.

Tool is equally satisfactory for drilling the troublesome terra cotta tile used as backing material in interior construction. Made in sizes ranging from $\frac{1}{8}$- to $\frac{9}{16}$-in., the new drill will work in any stonelike material by powering it with an air or electric power drill. Shank diameters range from $\frac{7}{64}$- to $\frac{1}{2}$-in.

Rules for use: 1. Slowest speed possible, through gear reducers chucked into electric drills, or low speeds on drill presses to give 20 to 40 sfpm.

2. Use plenty of coolant if water is used. With turpentine, feed in steadily with small spout oil can or one with a wick inserted.

3. Take up the stress on the glass by placing it on felt, section of carpet, or sponge rubber, to absorb vibration.

4. If a suitable tank is at hand, immersion in water makes drilling with the least risk of all.

Case of the Frozen Ammonia Condensers

By C. T. BAKER*

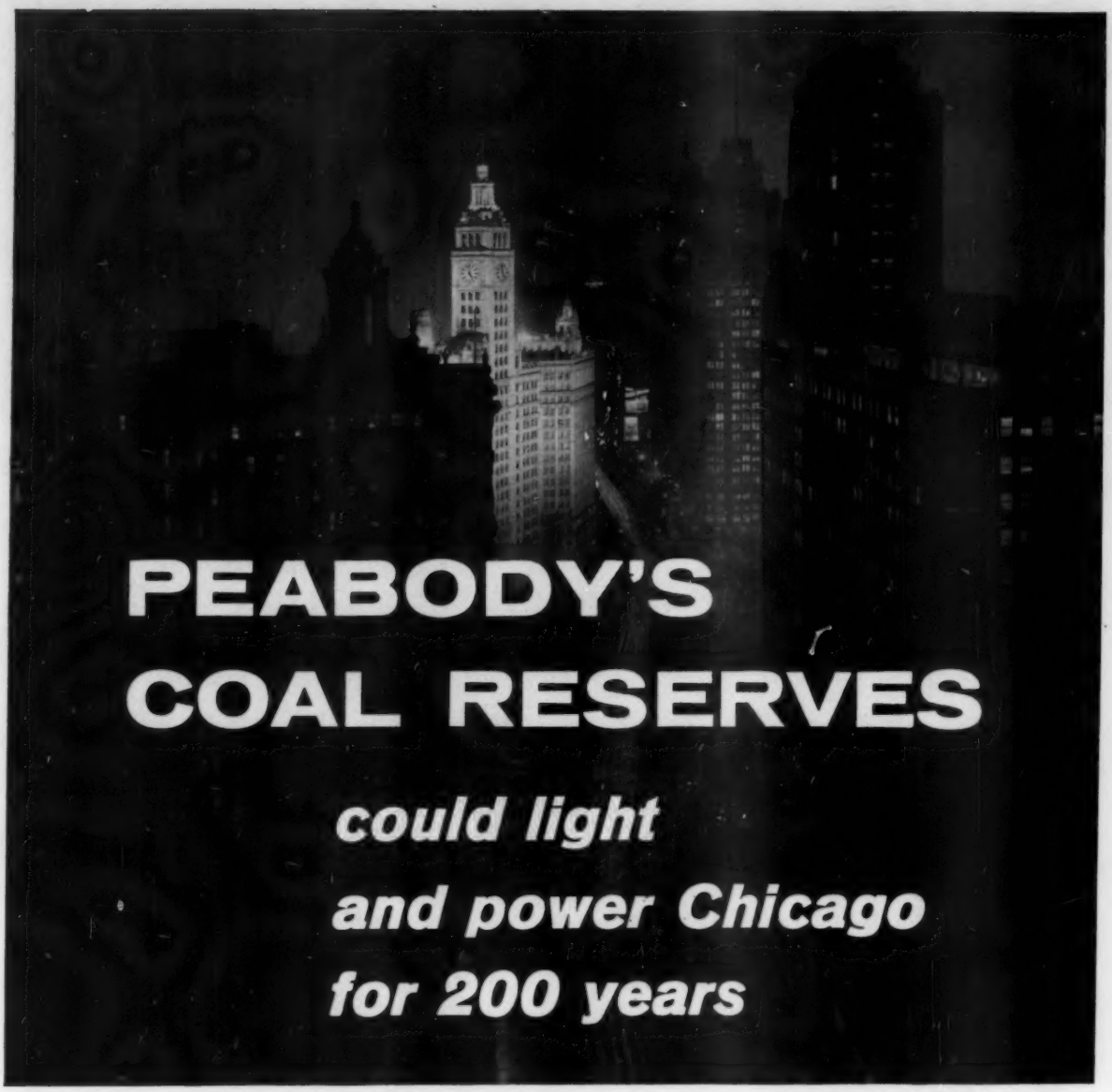
WATER TUBE in a stand of double pipe ammonia condensers of a 60-ton ice manufacturing plant developed a leak. Testing the water as it left each stand located the one that leaked. Gas inlet valve and liquid outlet of this stand were closed, thus taking the stand out of service.

Later, when preparing to remove the leaking inner tube, the inlet and outlet valve on the water supply were closed. Next, a temporary connection was made to the pump-out header that connected all condensers to a small pump-out compressor. The pump-out compressor was operated until the low pressure compound gage showed 10 in. of vacuum. Temperature of saturated ammonia at 10 in. of vacuum is −42 F.

Needless to say, all inner tubes of this stand were ruptured. They had to be replaced. Moral: always drain the water from double pipe condensers before attempting to pump out the coils.

In this case, failure to drain the condenser stand resulted in a sizable repair bill.

*Consulting Engineer



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How Do You Light Off a Cold Boiler?

A power plant chief is meeting after hours with a group of less experienced men from his crew. Objective is to raise and answer questions relating to operating procedures, and thus help the men gain efficiency in their jobs more rapidly.

This is a transcript from sessions of the operators' training program conducted at Lakeside station in Springfield, Illinois, by station superintendent F. H. Wilcoxen.

Three more of these Training Quiz sessions will appear in future issues of the Handbook.

CHIEF: Tom, what would you put down for Step No. 1 in lighting off a cold boiler properly?

Tom: I would check the oil torches.

Chief: You are supposed to do that on every shift, whether you start a boiler or not. Dick, what would you do first?

Dick: I would see if there is any water in the boiler.

Chief: Right. So we will put down . . .

Step No. 1 is to fill the boiler with water to proper level.

Chief: Where is the proper level, Jack?

Jack: About 2 in. in lower water glass, making sure it is a true level by blowing it down and watching to see that it bounces back.

Chief: Right. What will Step No. 2 be?

Jack: Check the boiler from top to bottom.

Chief: Correct. Then . . .

Step No. 2 is to check auxiliaries, dampers, drains, vents, doors, turn on cooling water to bearings, turn on quencher water and check boiler from top to bottom.

Chief: What do we do next, Joe?

Joe: Check on fuel and firing equipment.

Chief: Yes, you should be sure you have coal and lighting-off equipment in good shape. So . . .

Step No. 3 is to check on coal supply to lighting-off mill and all firing equipment such as burners, coal valves, secondary dampers, coal grates, scales and feeders.

Chief: Anyone have anything to add or disagree with before we proceed with Step No. 4? Who wants to say what we do next?

Jack: I would start the ID and FD fans and get the air adjusted for about — 0.3 in. furnace draft.

Chief: What would you do if the ID fan doesn't start when you try it?

Jack: Call the electrician or watch engineer to turn on the juice or check the circuit.

Chief: Assuming that the fans start okay, where are you going to set them, Lon?

Lon: I used to go by the fan speeds, or rpm.

Chief: You can set the fans at almost any speed and still get about — 0.3 in. furnace draft.

Lon: You set the FD fan at minimum stable speed and the ID fan to give you about — 0.3-in. furnace draft. This is about 180 rpm on the ID fan and 200 rpm on the FD fan, depending on the boiler. They are all a bit different.

Jack: Do you set your ID fan on automatic and the FD fan on manual? Some firemen do this.

Lon: The furnace draft must be set higher than the automatic when lighting off or the boiler will have a positive furnace draft and gas up the building. You can't put the ID fan on automatic until after the fire is stable in the furnace.

Chief: Before we go any further, let's start the ID fan and set it for — 0.5 in. to — 0.7 in. furnace draft and purge the boiler before we start anything else. It should be purged for at least 5 minutes. If you're going to stick a swab in a furnace in which there is no flame, you'd better purge it first, for there may be explosive gases in it. So . . .

Step No. 4 is to start ID fan and adjust for — 0.5 in. to — 0.7 in. furnace draft. Purge furnace for 5 min at this setting.

Going on to Step 5:

Step No. 5 is to start the FD fan and adjust for minimum stable speed. Adjust ID fan for — 0.3 in. furnace draft.

Chief: Now we have the fans running and adjusted. What do we do next?

Tom: The boiler room helper should check them to see that the oil rings are turning, etc.

Chief: That's always good operating practice when any equipment is started. Be sure it's running normally and is being properly lubricated soon after starting. What do we do now? Light the swab?

Dick: Start the fuel oil pump first.

Chief: Right. Then . . .

Step No. 6 is to start the fuel oil pump and light the swab. When the swab is burning all over, insert it quickly through burner port and light oil torch by opening oil valves.

Lon: Chief, will you explain where to set the lighting torch in the burner when lighting off?

Chief: It is very important that the lighting torch should be inserted until the cap drops off the end of the spreader pipe and then be pulled back so that the shoulder of the cap is against the end of the coal spreader pipe. Some firemen insist that the cap has to be loose or the oil will not come out of the torch. But if you have to loosen the cap to get oil, there's something wrong with the atomizing jet. Oil is just like coal; it won't burn if you blow it into the furnace in chunks. It has to be a fine mist to make a good flame.

What do we do next — assuming we are starting up a boiler having ball mills? We start the exhauster first, don't we, Tom?

Tom: Right. You have to start the exhauster before you start the mill.

Joe: Wait a minute. You have to get that exhauster up to minimum speed before you start the mill.

Chief: That's a good point. You should get the exhauster up to minimum speed before opening the coal-air valves, so that you won't have any flashback into the exhauster and mill. This will guarantee a velocity of 3000 ft/min, which will prevent flashbacks. This speed is adjusted by the manual automatic control station from the boiler panel; or in the case of a constant speed exhauster, you adjust velocity by damper opening. Now, when are you going to close your atmospheric or tempering damper and open your primary air damper?

Lon: You start the exhauster and then close the atmospheric damper and open the primary air damper. You set the

fold along this line—outside edges toward you

POWER ENGINEERING HANDBOOK

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exhauster for minimum safe speed and then open the coal valve.

Chief: So then we can agree that steps No. 7 and 8 are as follows:

Step No. 7 is to close atmospheric damper and open primary air damper.

Step No. 8 is to start exhauster and set for minimum speed or coal-air velocity, then open coal-air valve.

Chief: Tom, do you know where the primary and tempering dampers are?

Tom: Yes, they control the primary air that goes to the inlet of the mill.

Chief: Are we now ready to start the mill? Okay. Then . . .

Step No. 9 is to start mill, feeder and scale.

Chief: What is Step No. 10?

Dick: Increase exhauster speed until the coal starts to come out of the burner, say about 40 or 50, and then back it off a little.

Chief: If you have coal in the mill when you light off, you will get plenty of coal at about 30, or minimum speed. With an empty mill you may not get much coal for a few minutes. The flame will be unstable at this point, since mill, air and coal are cold, so you may have to use two torches and a swab to maintain an oil fire until the mill has ground and is delivering some coal to the burner. If you get the exhauster speed too high it may blow out the torch. So let's put down as Step No. 10 . . .

Step No. 10 is to adjust exhauster for minimum firing rate and good flame stability.

Dick: Don't you have to adjust the secondary air dampers when the coal starts to come out of the burner?

Chief: That's correct . . .

Step No. 11 is to open and adjust secondary air dampers. They should be open enough to give a good clear flame with some turbulence for proper coal and air mixture and enough to sweep the coal away from the ring tile and prevent coking under the burner. What do we do now that we have the burner lit?

Tom: I think you should look in the furnace and see if it's burning okay.

Chief: I like to see you boys look in the furnace occasionally and know what a good fire looks like. If you can see the tubes clear across the back wall, you know that the fire is burning okay, if the flame is stable at the burner tip.

While you are firing, the water will continue to expand. The water glass gage and column should be blown down two or three times while the boiler is coming up to pressure. This is important for several reasons. It gives you a true indication of where the water level is and tests for low water whistle. It cleans the water glass so that the level is easier to see. It also warms up the water glass gradually, thereby avoiding stresses causing the water glass to blow the gaskets. Avoid blowing with a wide-open valve.

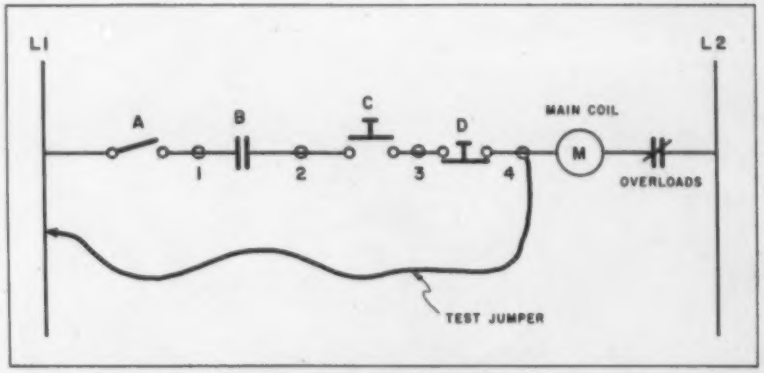
If you keep the superheater drains open wide enough, you will not have to use the water column to blow down water nor the mud drum blow-down valves when coming up to pressure — unless the water is too high when you start up. It is better to blow it through the superheater and keep it cooled properly.

Well, these seats may be getting a little hard, so we won't keep you fellows here any longer. Any more questions?

Shop-Made Steady Rest Is Light, Strong

Unlike the usual heavy, cast, king-size lathe steady rest, this unit is light in weight, yet has a capacity of 4-in. to 12-in. shafting weighing more than 1000 pounds. It was made by box-welding ¼-in. plate, plugwelded for strength. Easily handled, this steady rest is equipped with two sets of jaws. The jaws are faced with brass

fold along this line—outside edges toward you



Typical diagram for checking a simple motor control circuit. Jumper is moved successively along points

How to Trouble-Shoot Control Circuits

By MICHAEL LICHSTEIN*

WHEN TROUBLE-SHOOTING complicated electrical control circuits, either at the time a new plant is being put into operation or when a "bug" develops in an existing one, it is essential to check out a circuit as quickly as possible. Very often the trouble man traces out his circuit following a wiring diagram. This leads him through a rat's nest of wires, and becomes a long drawn-out process. Use of the schematic diagram will simplify and allow for a logical approach to the trouble-shooting problem. Having a systematic approach will save considerable time and trouble.

Procedure which helps to localize trouble using the schematic diagram requires only a test jumper. Basic plan is to test the main circuit element only, then progressively add one additional element at a time until the trouble shows up. In this way, the defective portion of the circuit is pin-pointed accurately.

Typical procedure for checking a relatively simple motor control circuit would work like this (see diagram):

Connect the test jumper to one side of the main coil and touch the other end of the jumper to the L-1 side of the circuit. The main coil should operate, which checks the continuity of the coil and the overloads.

Then with one end of the jumper still connected to the main coil at point 4, move the other end of the coil to point 1 and operate device A. The main coil should operate. If it doesn't, then there is trouble between L-1 and point 1.

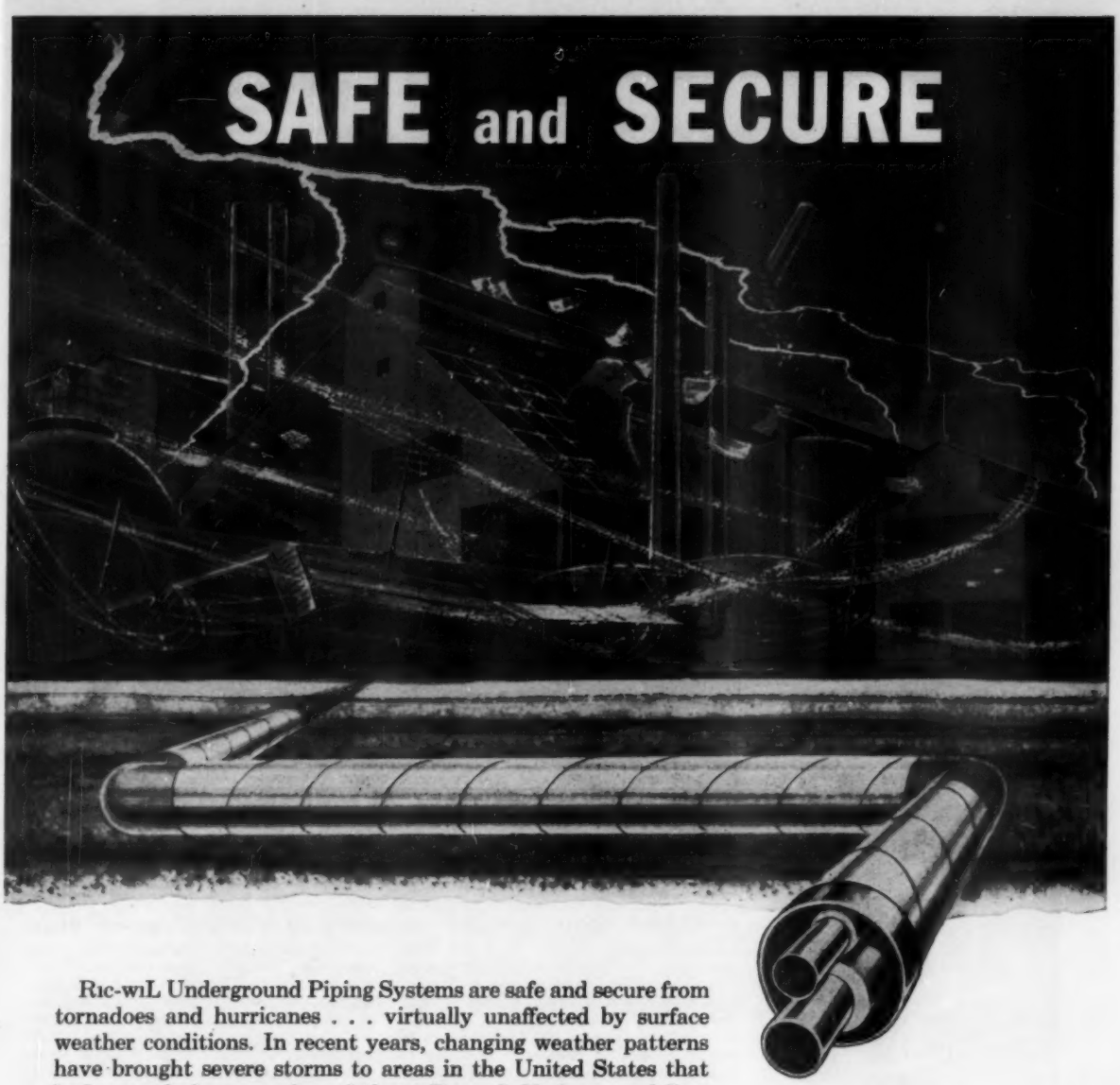
Successively move the jumper to point 2 and then to point 3, operating each new device that has been added. After a device has been tested and cleared, it should be left in the closed position so that the next circuit element can be tested.

This same method can, of course, be extended in checking out considerably more complex circuits.

* Electrical Engineer, United Engineers & Constructors, Inc

We'd like to hear from you

▶ Write us briefly describing that practical idea, method, tool or device that has helped you do a job better somewhere in the power field. For material accepted for publication in the Handbook we pay up to $35.



Ric-wiL Underground Piping Systems are safe and secure from tornadoes and hurricanes . . . virtually unaffected by surface weather conditions. In recent years, changing weather patterns have brought severe storms to areas in the United States that had never before experienced them. Ric-wiL Underground Systems remained unharmed . . . and in an emergency situation, immediate heat can be an important factor in restoring operations as quickly as possible.

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EQUIPMENT NEWS

Reader Service Cards on pages 133–134 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

1—ELECTROMAGNETIC PULLEY removes the tramp iron

This electromagnetic pulley is designed for removing tramp iron from belt-conveyed bulk materials. According to company, it retains operating advantages of two-coil design, and incorporates construction features that result in more protection for products and equipment. It is designed to provide a simple, effective means of magnetic separation and protection in normal material handling processes without altering the present system. It is claimed effective at belt speeds up to 600 fpm. Bulletin 1011 provides full information. Stearns Magnetic Products.

2—IMPROVED PUMP handles practically anything that flows

With only nine moving parts, the Free-Piston pump is reported to pump everything from molten metals to ice cream, including slurry, sludge, acids, semi-solids in stainless steel chambers. This pump is designed to impel a continuous air-free flow without pulsating or surging. It requires no safety or relief valves, says manufacturer; when a stoppage occurs, the pump stops. It can be operated submerged, if required. The pump is operated by compressed air introduced into each cylinder in sequence; while the left cylinder is discharging, the center cylinder has filled and is waiting, and the right is filling. Chambers fill by gravity. In each chamber is a nylon free-floating piston and two nylon ball valves. Operation is automatically controlled by a separate control box. It is noted that because one chamber can be stopped while the other two continue to function, the pump can operate indefinitely without shutdown. It can be made in size desired. The Crossley Machine Co.

3—UNIT SUBSTATION is compactly designed

This low-voltage Power-Zone, a package unit substation for use on 480-v systems to supply 120/208Y circuits, is designed for lighting, and similar loads. It contains three-phase transformers from 75 kva to 300 kva and offers up to 72 in. of panel space for molded case circuit breakers. The compact unit (60 in. long, 36 in. deep and 79½ in. high) goes easily through doorways, and, where space is critical, may be installed against a wall. Sound levels have been reduced to 45 db for sizes to 150 kva, 52 db for 225 kva, 56 db for 300 kva. Square D Co.

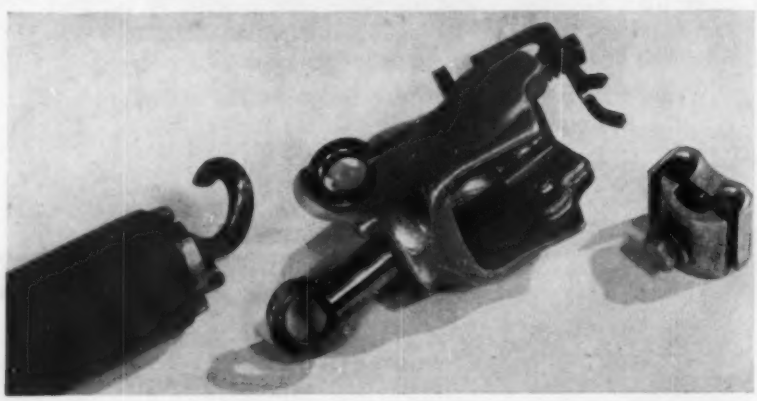
4—SYNCHRONOUS MOTOR stops, starts, reverses, steps

Called Slo-Syn, this enclosed permanent magnet type synchronous motor is adaptable for servomechanisms, automatic machines, remote control and numerical control systems. At 60 cycles, company says, the speed remains at 72 rpm without gear reduction. Torque is conservatively rated at 150 oz-in. It is pointed out that a single-pole, three-position switch can give instant starting, stopping and reversing control because the motor has three leads. When used as a stepping or inching motor, d-c impulses are converted into 200 or 400 precise increments of one revolution of motor shaft. There is said to be no excessive inrush current when the Slo-Syn is turned on because starting and operating current are nearly identical. Rated input is 120 v, 40/70 cycles, single-phase and current is 0.3 amp maximum at 60 cycles. Bulletin SS459 gives details. The Superior Electric Co.

5—CLAMP TOOL for use on energized electrical power lines

Called a clamp gripper tool for stick operation, this device installs clamps on "hot" electrical power lines with savings reported to average 80 per cent of the materials cost of clamps for such installations. Use of the tool (shown in center of photo) makes it possible to apply standard parallel groove clamps (right) to energized primary distribution or transmission lines, it is stated, making hot line clamps unnecessary. In effect, it performs the functions of the mechanism of a hot line clamp, but can be removed from the line after the simple parallel groove clamp is installed. Operated by the hook of a hot line stick (left), this tool may be used with most common "shotgun" type hot line sticks.

An assembly of components in a cast aluminum housing, this tool is a joint development of Aluminum Co. of America and Standard Coil Co.; the latter manufactures it. Efficiency of a joint made by a parallel clamp installed with this tool is claimed equivalent or superior, electrically and mechanically, to joints made with a hot line clamp. Use of the clamp tool is not difficult, it is claimed, as the motions and actions involved are essentially similar to those of installing conventional hot line clamps. Aluminum Co. of America.



6—TIMER features time selection and visual time indication

Since the dial of this 30-min synchronous motor-driven timer is marked off in minutes with half-minute graduations, the exact time is selected simply by rotating a bronze pointer to the timing cycle required. While in operation, the timer dial shows the full timing interval and time remaining in the cycle. In case of power failure the timer is designed to return automatically to its starting position for a full cycle when power returns. Cutler-Hammer Inc.

7—BANDING TAPE has high tensile strength

Tensul-Tape is announced as an electrical coil banding and tying tape with high tensile strength and minimum stretch, well suited for liquid filled transformers and repairing and rewinding heavy-duty coils and armatures. It is made from unbleached, warp twist, cotton yarn in which parallel strands, bonded with adhesive, run lengthwise only. There is no unnecessary cross-weave, company states, and tape is free of impurities. It comes in transverse-wound spools of 250–1000 yd, or 100-yd convolute-wound rolls. General Printed String Co.

3 PRESSURE CLASSES

1500-Pound ASA—in carbon steel (WCB)

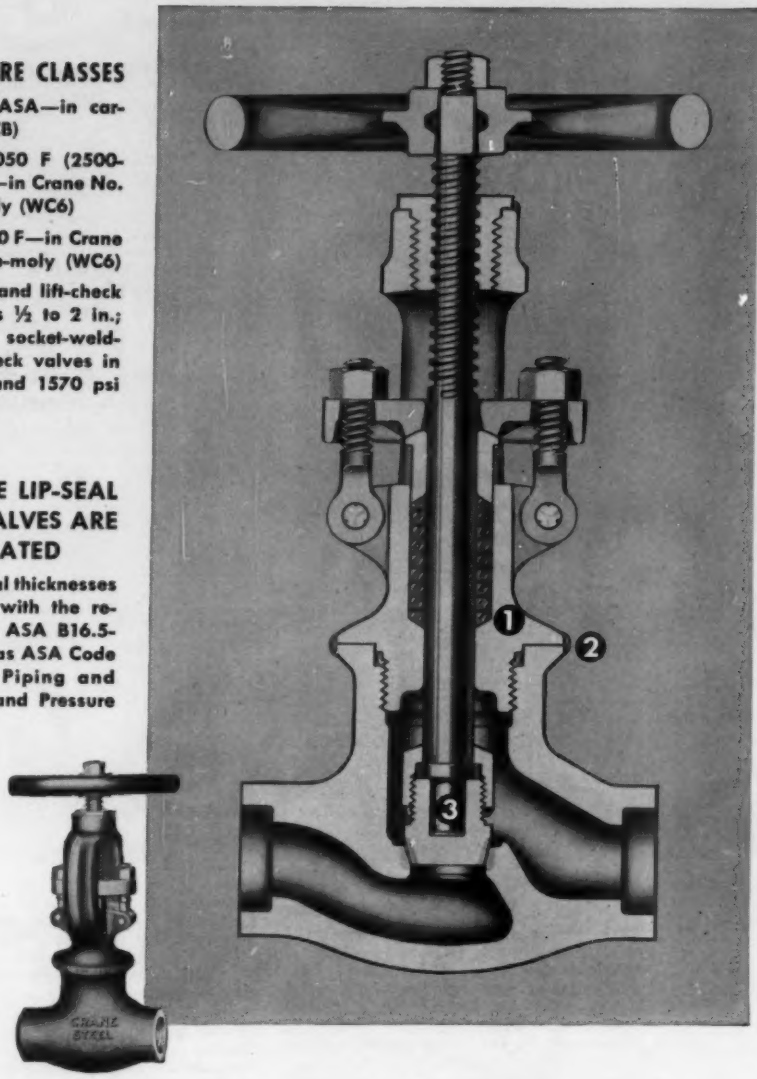
1570 psi, 1050 F (2500-Pound ASA)—in Crane No. 7 chrome-moly (WC6)

2520 psi, 1050 F—in Crane No. 7 chrome-moly (WC6)

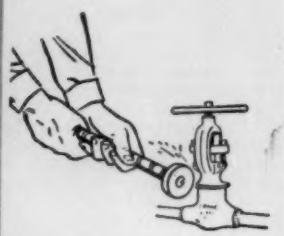
Globe, angle and lift-check patterns; sizes ½ to 2 in.; screwed and socket-welding ends. Check valves in 1500-Pound and 1570 psi ratings only.

ALL CRANE LIP-SEAL BONNET VALVES ARE ASA-RATED

Minimum metal thicknesses comply fully with the requirements of ASA B16.5-1957, as well as ASA Code for Pressure Piping and ASME Boiler and Pressure Vessel Code.



1 New centering shoulder assures perfect body-bonnet alignment. No chance of stem misalignment.



2 Welded body-bonnet Lip-Seal—eliminates bonnet joint maintenance. The seal-weld carries no mechanical load; it seals the bonnet joint only. Lip design permits convenient grind-off, easy rewelding.

3 Disc-stem connection. Improved design brings stem thrust closer to seating surface, minimizes vibration, does not interfere with swivel action of disc.

Today's ultimate in small high pressure valves —Crane Lip-Seal Bonnet Globes

These *accurately rated*, small high pressure valves—now in *three* pressure classes—meet all power plant service specifications for boiler feed, drips and drains, blowdowns, bypasses, and similar applications.

Here are compact yet rugged valves that provide precision throttling with minimum vibration of disc and reduced wear on seating faces—all with *low maintenance cost.*

The patented Lip-Seal bonnet alone gives these valves outstanding value. Strong, streamlined body . . . Stellite-faced, plug-type disc and seat . . . fully guided stem and disc . . . 2-piece, ball-type packing gland with stainless steel, swing-type eyebolts . . . these and more refinements all combine to make Crane Lip-Seal Bonnet Valves today's ultimate in their class.

For complete details, ask your Crane Representative for Bulletin AD-2373 or write to address below.

Ask for Bulletin AD-2373

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Illinois—Branches and Wholesalers Serving All Areas

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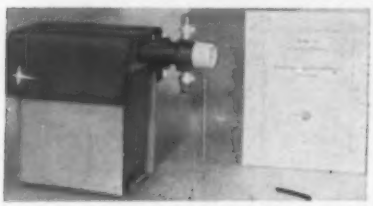
8—ADHESIVE-SEALER can repair almost anything

Liquid Iron is announced as a putty-like synthetic plastic that sets into a substance like iron a few hours after it is mixed with a liquid hardener. Once hardened, it can be ground, sanded, shaped, filed or drilled. According to manufacturer, a Liquid Iron bond retains its strength under heat up to 300 F, and cold down to zero, and is generally stronger than the materials bonded together. Among many applications are repair of worn valves, machinery and broken castings.

Liquid Iron comes in a package containing a jar of putty-like base and a vial of hardener. When the two units are mixed, a chemical reaction takes place. You put the mixture on with putty knife or trowel and it begins to harden within an hour, is fully hardened by 12 hr. Neither heat nor pressure is required, but heat speeds hardening. Durable, non-shrinking and non-expanding. Liquid Iron withstands mild acids and alkalis, it is claimed, and can be painted with any type of paint. You can use it with iron, bronze, wood, aluminum, brass, porcelain, glass, marble, other materials. Its multiple applications are attributed to fact it is both bonding agent and filler. Cycleweld Chemical Products Div., Chrysler Corp.

9—PROPORTIONING PUMP for small, low pressure boilers

Proportioneers Model 1107 Adjust-O-Feeder, a plunger-type, small capacity proportioning unit is announced as providing low-cost injection of treatment chemicals for smaller boilers. It is suggested for treating make-up water, or for constant feeding at low rate. It is also suitable for proportioning chemicals in water and sewage works, chemical and food processing etc. Design features include adjustable stroke length to give feed rates from 0.2 to 2 gph into 300 lb maximum discharge pressure. The unit handles amines, caustic, disodium phosphate, poly phosphate, sodium sulfite, others. It operates on 110 v, 60 cycles, has a built-in reduction gear box and thermal overload protection. B-I-F Industries, Inc.



10—FUEL GAS VALVE offers greater flow, greater safety

Hi-flo Valves incorporate straight-through, non-turbulent flow with a fast-acting, fail-safe shut off. These valves are used for on-off control and safety shut off for gas-fired boilers, heat treating furnaces, drying equipment etc. Their design is said to offer advantages over globe type valves, including delivery of up to three times greater flow for a given line size because the inner valve in the open position is withdrawn from the main gas stream. Hi-flo Valves are self-contained and their construction eliminates reduction gears and linkages. Manually reset and electrically reset actuators are available. Pipe sizes from 1 to 6 in. are accommodated; gas capacities up to 54,000 cu ft per hour at 1 in. pressure drop are handled based on 0.7 specific gravity of the gas. General Controls, Inc.

11—FOAM SOLVENT METHOD cleans industrial equipment

In this method of cleaning with chemical lather or foam, the foam solvent is pumped from a unique apparatus directly into the tank, pipe or tower to be cleaned. When the tank is filled with foam, the process continues with the foam passing into a foam breaker and a filter which removes material dislodged by the movement of the foam through the equipment. The solvent is then recycled through the foam generator and the unit being cleaned.

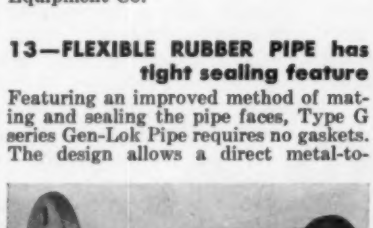
This method is reported suitable for many cleaning jobs formerly not possible or too expensive with liquid solvents. It enables cleaning of large volume systems with a relatively small amount of liquid because the ratio of foam to solvent averages 20 to 1. It is claimed possible to clean equipment that would not stand the weight and hydrostatic pressure if liquids were used. It is also possible to use concentrated chemical solvents where needed, company states, and the foam technique enables removal of sloughed materials because of the excellent particle-carrying property of the foam. Due to the many chemicals and solvents available, a foam solvent for nearly every type of deposit can be tailor-made. Dowell Div., The Dow Chemical Co.

12—TENSIONING EQUIPMENT for conductor pulling

This tensioning equipment consists of two pieces — puller and tensioner. The former is a multiple reel pulling trailer consisting of four reels powered by a 30-hp air-cooled engine on a trailer chassis. The engine operates through a four-speed forward, one-speed reverse hydraulic transmission with fluid coupling to furnish each of the four reels with 2000 lb of pull. Each reel on the pulling trailer has 2500 ft of rope, so that over ½ mile of four conductors can be pulled simultaneously. The tensioner is a multiple reel stringing trailer that will pay out four reels of conductor under 2000-lb constant tension. Each reel can be tensioned individually. Truck Equipment Co.

13—FLEXIBLE RUBBER PIPE has tight sealing feature

Featuring an improved method of mating and sealing the pipe faces, Type G series Gen-Lok Pipe requires no gaskets. The design allows a direct metal-to-metal bolting to the pipe, with the rubber flange of pipe acting as its own gasket as it is compressed to form tight seal. The split retaining rings, of cast semi-steel, are designed for fast, snug mating of rings halves. Pipe comes in standard diameters from 1 to 12 in. ID, in any standard face-to-face length, for working pressures of 150 to 250 psig. It can also be used for vacuum service. Type G pipe is suggested for piping systems handling corrosive liquids or slurries, as well as in air conditioning, heating, refrigeration systems. Bulletin 580 gives details. General Rubber Corp.



14—BATTERY CHARGERS move on wheels or mount on wall

Variable Voltage Rectifiers (VVR) are designed to charge an entire battery, any cell, or group of cells within the battery up to the charger's rated capacity. The line includes models for use on batteries with up to 32 lead-acid cells or 50 alkaline cells, available in cabinets with wheels or for wall mounting. They are equipped with silicon rectifying diodes. To operate one of these chargers you simply connect a-c lead to proper power source; connect d-c leads, marked for proper polarity, to battery; push a-c breaker switch to "on" position; and turn the Powerstat transformer control clockwise to point where ammeter registers desired charge rate. Manufacturer points out that with no moving parts other than required relays and contractors, maintenance of these chargers is minimized. Exide Industrial Div., The Electric Storage Battery Co.

15—SELECTOR SWITCH provides easy operation

For directing or stopping flow of compressed air to pneumatic motors and valves, this remote selector switch is 10 per cent smaller than former models and designed to match company's positioning switch announced earlier this year. By replacing leather with Teflon plastic for the disc in the switch body, friction and air leakage have been reduced and the selector knob is easier to turn, company says. The selector switch can be used to divert control of an air-operated system from one instrument to another, to control a system of valves, dampers or pneumatic electrical equipment, and to change system air supply pressures. For central panel mounting, the switch needs only 2⅜ by 3⅛ in. of space. Its depth is 3¼ in. and it can be flush or surface mounted. Two, three, or four port arrangements can be made on the

"When I order salt, I want salt—not salt and a lot of sludge!"

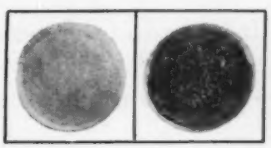
Buy Purex Salt—it's sludge-free!

You get what you want when you order Morton Purex Salt. It's the high-purity, economical, evaporated salt that's 100% soluble. None of your purchase price or freight bill goes toward paying for insolubles or sludge that are often present in ordinary salt.

What's more, Purex, unlike common granulated salt, is made in a controlled-particle size to prevent packing and channeling in brinemaking equipment.

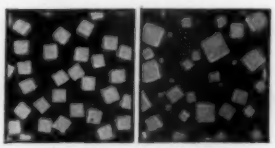
Brine tanks never need cleaning out

With sludge-free Morton Purex Salt, you prevent costly shutdowns for maintenance . . . save time and completely eliminate labor costs for cleaning out brine tanks, and you end the problems associated with dissolving salt of uneven particle size. Purex can be used in bulk wet-storage systems and in both the regular and the new fiber-glass Morton Model-E Brinemakers.



Purex **Ordinary Salt**

These filter pads (approximately 1/6 actual size) compare the amount of insolubles in 5-lbs. of ordinary salt with 5 lbs. of Purex. Morton Purex contains no wasteful sludge or insolubles.



Purex **Common Granulated Salt**

This close-up view shows you how Purex Salt, compared to common granulated salt, is more uniform in size, helping to prevent packing and channeling in brinemaking equipment.

For more information about Morton Purex Salt and for free, expert help on water-conditioning or brine-making problems, write or wire:

MORTON SALT COMPANY

INDUSTRIAL DIVISION

Dept. PE-9, 110 No. Wacker Drive, Chicago 6, Illinois

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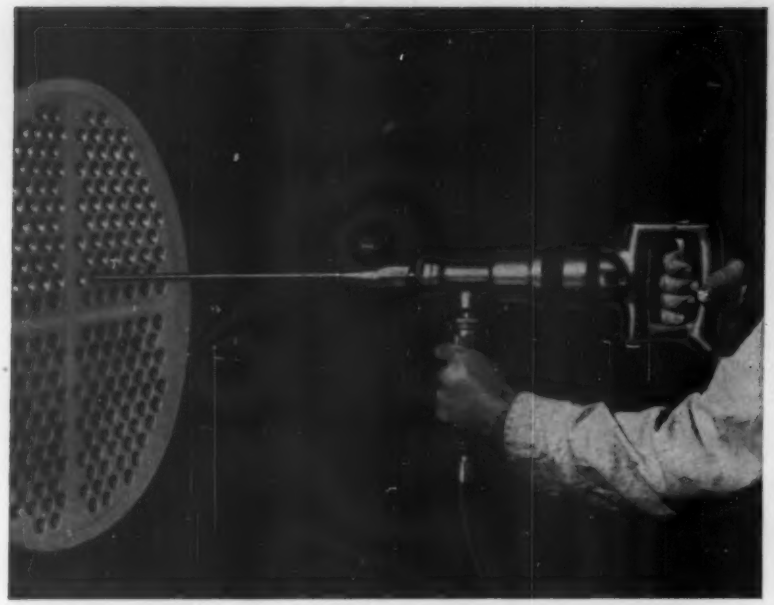

One man handles this powerful Airetool tube cleaner...without a rig

There's no other tool like this Airetool Model CC-475 heat exchanger and condenser tube cleaner. It weighs just 10 lbs. One man handles it easily — without a supporting rig. Yet, it's powerful enough to clean all severely clogged tubes up to 1″ diameter. Built-in flushing system washes away debris, cools drill head — keeps work moving at a fast pace.

You get this same time and cost-saving performance from Airetool straight tube cleaners and pneumatic, as well as electric tube expansion control systems. Write for Bulletin 66. *The Airetool Mfg. Co., Springfield, Ohio*

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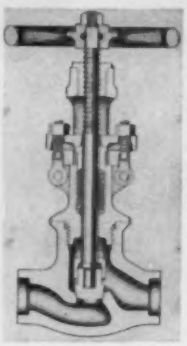
same body. Eight dial styles and three nomenclature plates are available. Air capacity is 580 cim. Information is in Bulletin 357-2 and Form P-79. The Powers Regulator Co.

16—BONNET VALVES in three pressure-temperature groups

This revised and expanded line of lip-seal bonnet valves covers three distinct pressure-temperature classifications rather than the two previously produced. The 3800 series of 1500-lb valves at 850 F comes in cast carbon steel in globe, angle and lift-check types. The 3900 series of 1570-lb valves at 1050 F is made in a cast chrome moly steel in globe, angle and lift-check types. The 4000 series of 2520-lb valves at 1050 F is produced in the same cast chrome moly steel, in globe and angle models. The valves, in sizes from ½ through 2 in., have been redesigned to provide a centering shoulder to avoid possibility of stem binding. Crane Co.

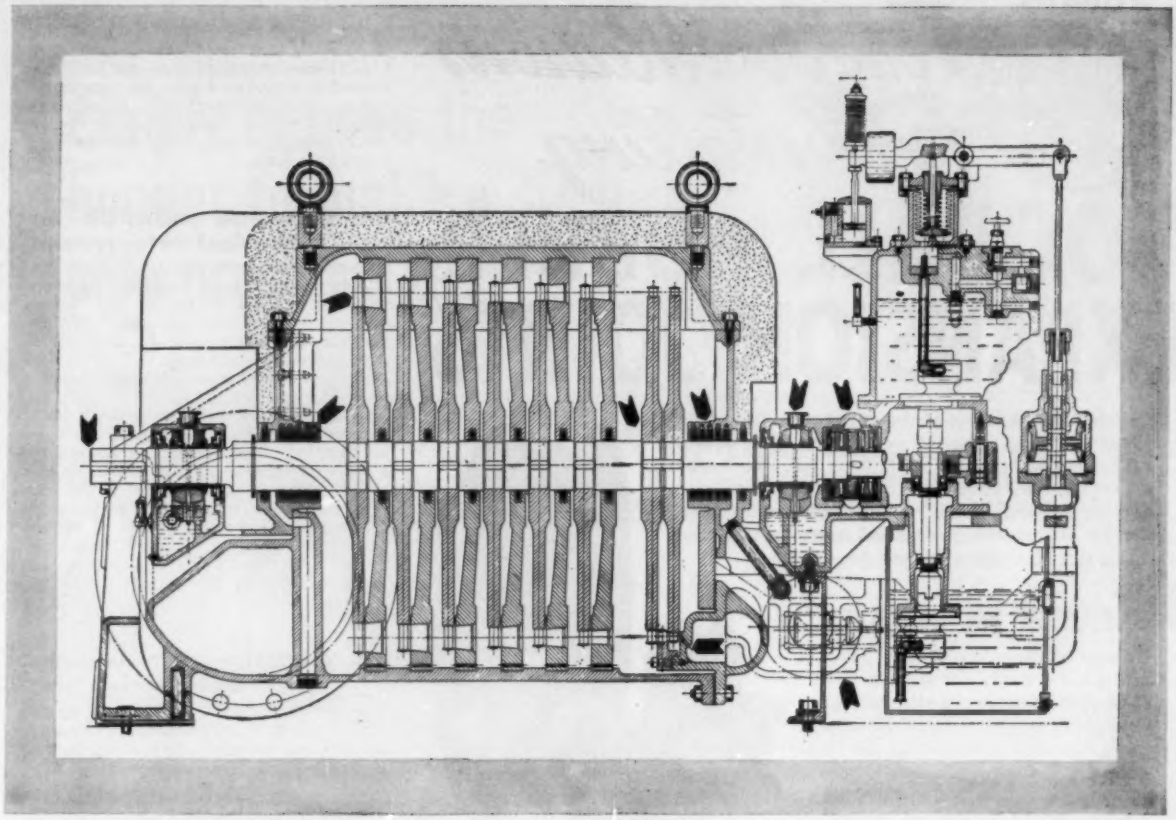


17—METAL PACKING for high pressures, temperatures

Lonsor is a plastic metallic packing. Manufacturer says it never deteriorates or hardens, and never needs to be replaced, only added to. It comes in 1-lb wrapped cakes and is easily broken off and stuffed into the box, gland or shaft by hand. Being pliable, Lonsor conforms to rod or shaft to make a perfect bearing surface. Its inherent self-lubricating properties, derived from its antimony content, results in frictionless running, company says, and its lead base makes it impervious to acids. It can be used in valves, stuffing boxes, pistons, cylinders, valve stems, centrifugal or rotary shafts and in steam engines, pumps, air compressors, turbines, etc. It is designed to withstand high pressures and temperatures to 700 F. Newage Industries, Inc.

18—PORTABLE WELDING MACHINE for aluminum pipe

This automatic circumferential welding machine for butt welding aluminum pipe comes in several sizes weighing from 40 to 50 lb. To make a joint, the unit is held in position by a strap clamp and



ANOTHER INSIDE STORY OF THE UNIVERSAL ACCEPTANCE OF MURRAY MULTI-STAGE TURBINES IN THE MECHANICAL DRIVE FIELD

- Husky accurately machined shaft.
- Discs shrunk and keyed in place.
- Stainless steel nozzles and blading throughout.
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- Kingsbury thrust bearing.
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Our nearest representative will gladly help you solve your mechanical drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa, for his name.

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Builders of Steam Power Equipment for Nearly a Century

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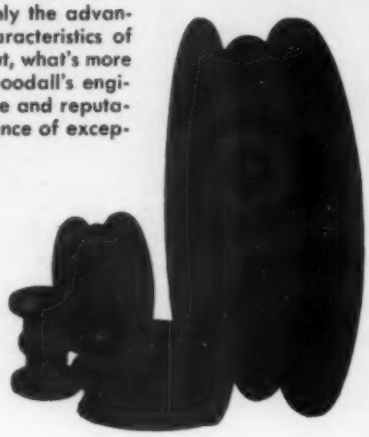
Four Good Reasons For Installing GOODALL RUBBER EXPANSION JOINTS

Goodall Expansion Joints have not only the advantages stemming from the natural characteristics of rubber for all types of installations, but, what's more important, they have back of them Goodall's engineering skill, manufacturing experience and reputation for quality that give added assurance of exceptional service under all conditions.



EASIER TO INSTALL...

Goodall Rubber Expansion Joints are quickly, easily installed on new construction or as replacements. They are light in weight to facilitate handling, with short face-to-face dimensions for easier application where space is limited. Retaining rings are quickly aligned and bolted. No gaskets are required.

RESPONSIVE TO MINIMUM PRESSURE...

With Goodall Rubber Expansion Joints only the slightest pressure is required to create movement in any direction. Result—stress on metal pipe or other member is eliminated or, at most, reduced to an absolute minimum.

MANY SIZES...HIGH WORKING PRESSURES...

Goodall Rubber Expansion Joints are available in sizes from ⅜" to 96" I.D., in all required styles and constructions. Working pressures range up to 125 P.S.I. for Pressure Joints, and to 90 P.S.I. for Vacuum-Pressure Joints, depending on size.

LONGER SERVICE LIFE...

Goodall Rubber Expansion Joints last longer in service because of inherent characteristics of the material from which they are made. There is no embrittlement... continuous movement (flexing) actually keeps the rubber joint "alive". There is no corrosion or electrolysis. Resistance to abrasion is exceptionally high. Replacement costs are lower.

"If it's GOODALL, it MUST be Good"

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Standard of Quality—Since 1870

HOSE · BELTING · FOOTWEAR · CLOTHING
AND OTHER INDUSTRIAL RUBBER PRODUCTS

GOODALL *Rubber Company*

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

BRANCHES AND DISTRIBUTORS THROUGHOUT THE UNITED STATES.
IN CANADA: GOODALL RUBBER CO. OF CANADA LTD., TORONTO.

For more data circle 553 on Post Card

the welding gun and cable drum gear travel around the horizontal axis of the pipe. With this simplified equipment, a 4½-in. diam standard pipe can be butt-welded in less than 1 min, manufacturer states, and without any "programming". The unit operates with conventional engine driven d-c power sources. Aluminum Ltd.

19—RADIATION MONITOR for municipal water systems

This super-sensitive monitoring system is designed to keep a constant check on traces of radioactivity in city water systems — to record normally minute and harmless amounts and immediately detect significant increases. The equipment, connected into the water supply at one or more key points, so that its crystal detector, sensitive to both beta and gamma rays, is exposed to the flow at all times. The detector is housed in a stainless steel-lined lead shield to exclude normal atmospheric radiation. Water flows through the housing continuously and trace amounts of radioactivity generate a signal. This is amplified by a device which controls the marking pen on the chart. Victoreen Instrument Co.

20—TRANSFORMER is versatile "do-it-yourself" unit

The Flexiformer, a packaged transformer primary, makes stocking of many fixed-ratio transformers unnecessary. Essentially, a Flexiformer is a self-

contained toroidal primary coil consisting of a strip-wound silicon steel core having a coil of 400 turns of No. 24 B&S gage copper wire. For use as a source of a-c voltage, you simply hand-thread the proper number of secondary winding turns through the center opening to obtain the desired output voltage. Input rating is 120 v, 50/60 cycles, single phase and output is 150 va. When used as a current transformer, the Flexiformer winding becomes the secondary winding with current induced by a wire passing through center opening. Used with a 0–1 amp ammeter, currents to 400 amp can be measured. Flexiformers can be used for testing current carrying capacity of contacts, connectors, relays, circuit breakers, fuses etc. Bulletin TP659 gives more information. The Superior Electric Co.

21—DRAFTING FILM gives long life to drawings

Flexibility and strength of its Cronar base gives Futura Drafting Film more permanence, it is announced. According to manufacturer, this film won't crease and can't crack or yellow with age. It is available with a matte finish on one or

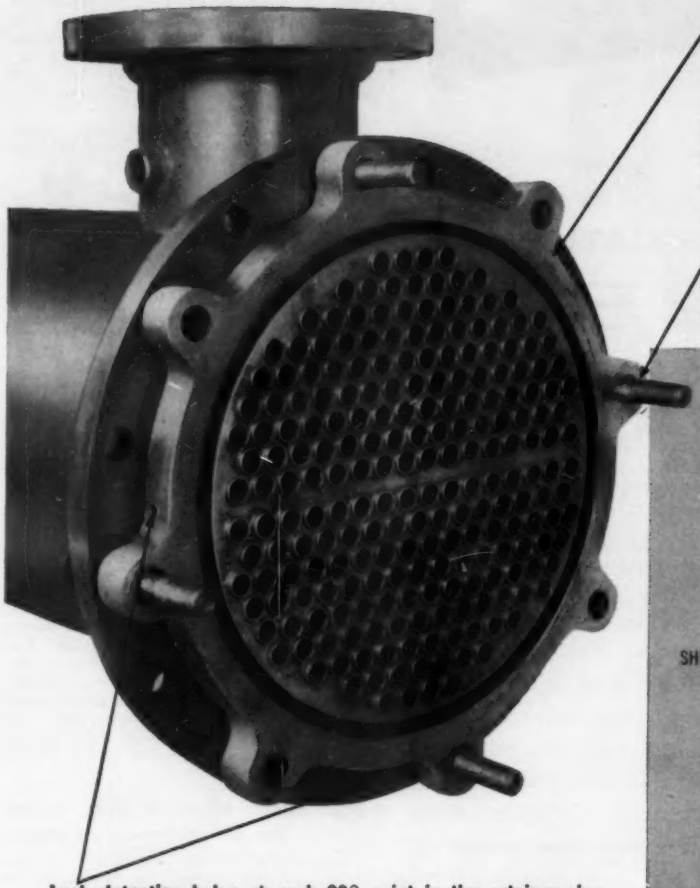
Simply remove the bonnet to make a shell side pressure test

Paracoil

EXCHANGER TYPE **PC**

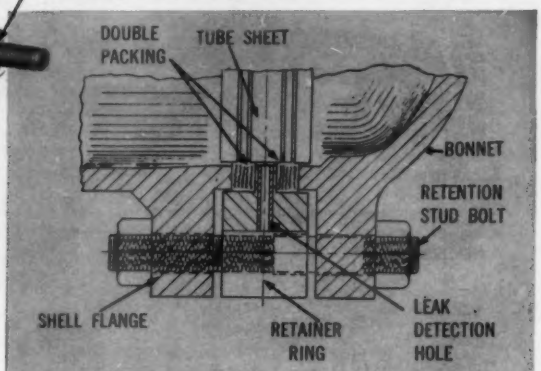
FOR ☐ COOLING ☐ HEATING

☐ OIL ☐ WATER ☐ AIR ☐ GAS



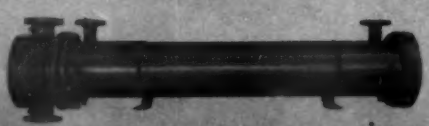
Unique retainer ring permits fast, easy inspection and servicing of packing. All that is necessary to set up a shell side pressure test is to remove the end bonnet by backing off on its single set of holding nuts. The retainer ring continues to hold the shell side packing in compression (see details below). No clamps or special devices needed. Piping connections are left undisturbed.

Retention stud bolts pass through the shell flange and screw into threaded retainer ring lugs, holding the ring and packing in place with bonnet off.



HOW IT WORKS

Section at packing retainer ring weephole. Seepage from either shell or tube sides drips out through copper-lined weephole. If tightening the gasket compression nuts fails to stop the leak, simply remove the end bonnet and pressure-test the shell side to locate the trouble—either the tube-end rolling or the shell-side packing. If neither, then the tube-side packing is at fault.



PARACOIL TYPE PC EXCHANGER

Leak detection holes at each 90° point in the retainer ring reveal any leakage past either the shell or tube side packing. **The absence of leakage indicates that the packing is holding—hence no dismantling is necessary for packing inspection.**

PARACOIL PC Exchanger tubes are straight for easy cleaning. The tube bundle is fully removable.

THESE DESIGN FEATURES SAVE HOURS OF MAINTENANCE TIME EVERY INSPECTION.

For details, write for Bulletin 140-A

DAVIS ENGINEERING

(A Division of American Metal Products Company)

520 Main Avenue, Wallington, N. J.

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FOR CUSTOM FABRICATION

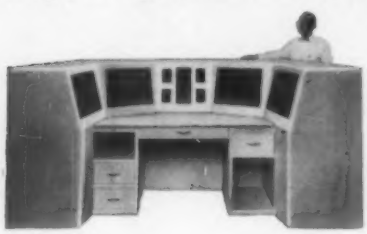
SPECIFY *Kirk and Blum*

What is the most economical way to fabricate your components? Ask Kirk & Blum . . . a firm that, for more than 50 years, has maintained the confidence of the nation's outstanding manufacturers with substantial savings in time and cost.

Kirk & Blum's experienced craftsmen are adept at a multiplicity of production techniques for maintaining quality and uniformity at lowest cost. Often, they develop special tooling that opens new vistas of economy.

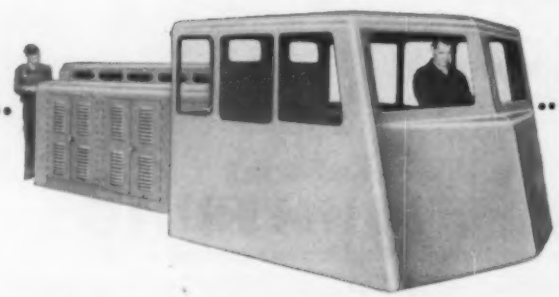
The extensive facilities and equipment of Kirk & Blum's 170,000 sq. ft. plant offer a capacity for sheet steel fabrication to ½" thickness. Working with aluminum, copper, monel, stainless and other alloys is a K&B specialty.

Request your copy of the new 40-page Kirk & Blum Sheet and Plate Fabrication Catalog. Better yet, send us your prints for prompt quotation.



THE KIRK & BLUM MANUFACTURING CO.

3230 FORRER STREET, CINCINNATI 9, OHIO



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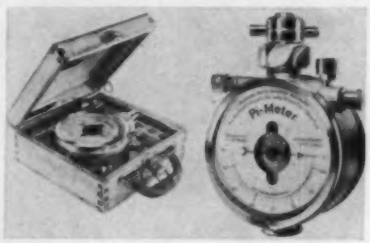
both sides. This finish is prepared for pencil drawings over a wide degree of lead weights without cutting the film. Erasures don't leave ghost line or smudges or mar the surface, it is stated, and the film is also suited for ink drawings or for printing. Other qualities announced include optical clarity, dimensional stability, sheet uniformity and glare-free surfaces. Futura Drafting Film comes in sheets and rolls. Chart-Pak, Inc.

22—PERFORMANCE METER for multi-cylinder engines

For rapid adjustment and balancing of cylinder loads of multi-cylinder diesel, gas, steam and gasoline engines, the Pi-Meter can be attached to the cylinder's pressure tap. This simple instrument reads time-averaged pressure which is related to indicated mean effec-



tive pressure. Since this pressure (psi) is read directly on the meter's dial while the engine is running, it can be used by non-technical personnel. Five springs within the Pi-Meter accommodate a wide enough pressure range to adapt it for use with any type of reciprocating engine.

The Pi-Meter has no upper speed limit (lower limit is 80 rpm) and is therefore especially useful in determining power output of high speed engines, once a chart has been plotted relating to the instrument's reading to the mean effective pressure of the engine. For continuous operation, the Pi-Meter can be water-cooled through a threaded connection. For lubrication of piston contact surfaces during operation, the instrument incorporates a hand pump with check valve. The Korfund Co., Inc.

23—ACID NEUTRALIZER raises the pH of corrosive water

This soluble alkaline product is for use with solution feeders to neutralize or raise pH value of corrosive water. Formulated to dissolve rapidly and form a sterile feed solution, the compound helps stop blue or green staining sometimes caused by corrosion of copper plumbing. It does not crystallize out of solution during cold weather, says manufacturer, and is compounded to prevent precipitation of scale in feeding equipment. For most installations company recommends a starting dosage of 20 ppm of the acid neutralizer. Proper feed rate is obtained when pH reaches 7.2. A 40-lb drum costs around $25.00. Calgon Co.

24—PIPE HANGERS provide constant load support

For piping systems subject to expansion and contraction due to temperature changes, Counterpoise Hangers are basically spring-actuated counterbalances. They are designed to produce a

NEW
high capacity
BRONZE PORTABLE VALVES
reduce initial valve cost

Consolidated Safety Valve Type 1540 Series. Sizes: ½" thru 2½". Pressures to 250 psi. Temperatures to 406°F. Available with side or top outlet.

These new Consolidated Safety Valves are specifically designed for such applications as package-type steam generators, fire tube boilers, and air compressors. High-capacity design reduces the size and/or number of safety valves required.

You can be sure of stable performance and uniform blowdown control. These bronze portable valves have a precision-wound, calibrated spring aligned with cone-shaped spring washer bearings. The integral combination adjusting ring and disc guide are double guided. Alignment is better, blowdown adjustment is easier, operations finer. Positive tightness is certain: the seat is machine lapped to optical flatness. Opening is sharp and clean, without simmer. Lifting lever is fully adjustable over more than 300°.

When a lower capacity rating is adequate, you can choose valves in medium capacity to conform closely to actual capacity requirements. Capacities, sizes and descriptions of new Consolidated Bronze Portable Safety Valves are given in Bulletin 740. Write for a copy.

Industrial distributors in all principal cities backed by convenient regional warehouses are ready to serve you.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

CONSOLIDATED SAFETY VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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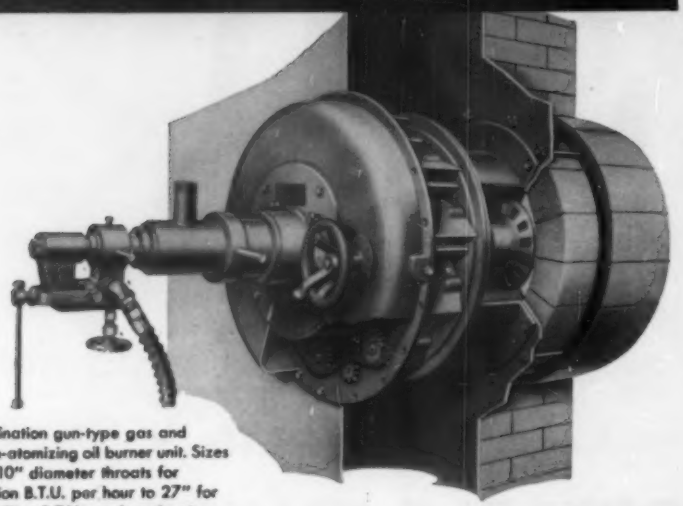
ENCO

TYPE E OIL BURNER UNIT



Combination gun-type gas and steam-atomizing oil burner unit. Sizes from 10" diameter throats for 7 million B.T.U. per hour to 27" for 100 million B.T.U. per hour input.

Saves Money and Troubles IN 5 WAYS

1. Vanes can't stick—Easily adjusted

Air register vanes are easily adjusted by a single hand wheel for either clockwise or counter-clockwise air rotation. The action is without stiffness or sticking. Vane shafts are stainless steel — heat-resistant, corrosion-proof — turn smoothly in carbon graphite bearings at all operating temperatures.

2. Positive Vane Control —no lost motion

Chain-and-sprocket air-vane control, with take-up adjustments, assures easy and precise setting at all times. There are no links to wear and wobble with a flopping action of the vanes when they pass dead center.

3. Adaptable to oil or gas —or both

Changeover from oil to gas or a combination of both can be done easily — with comparatively low cost standardized parts—to get the full advantage of variations in fuel prices.

4. For wide range or standard range burners

Registers accommodate standard range or wide range oil burners — mechanical or steam atomizing — and gun type or ring type gas burners—the one best type or combination for your individual needs.

5. Adaptable to all housing designs

Extra deep burner housing can be used to suit practically any fan and any duct arrangement — with lowest installation cost — and provide proper air distribution for efficient combustion.

Bulletin G59 gladly sent on request

BC913

THE ENGINEER COMPANY

75 WEST STREET, NEW YORK 6, N. Y.

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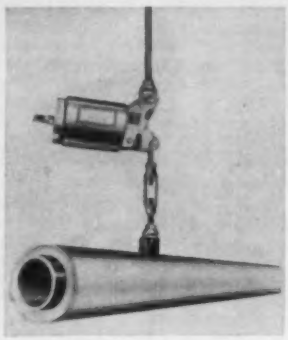
constant supporting effect on loads which travel in vertical directions and are applicable to piping system movement requiring flexible support. Main load-carrying parts are at one end of the

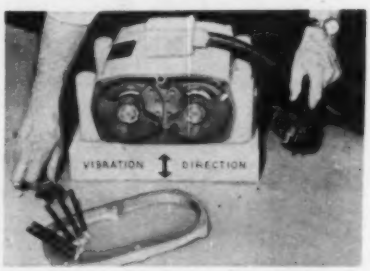


structure, simplifying design and permitting installation of hanger in congested locations. The over-hanging spring assembly can also be revolved at any angle about the load and support rods. Flexibility is also provided for in top connections for an appreciable angularity of load movement.

Short vertical distance between support and load connections permits installations where headroom is limited, and in case of extreme limitation, the turnbuckle, providing rod adjustment at end of load rods, can be eliminated. A variety of sizes are available in four basic types: single and double suspension models, a vertical model, and a lightweight junior model. Fee & Mason Mfg. Co., Inc.

25— DUAL MOTOR VIBRATOR geared for synchronous action

Model RC-31 is designed to produce straight line vibration, in any direction. It operates on a rotating eccentric weight principle and features adjustable



eccentrics, permitting force of vibration to be varied without changing weights. There are four weights, two on each motor, contra-rotating. Variable impact range is 640 to 2200 lb and impact changes can be made quickly. Because there are no pulleys or belts within this totally-enclosed vibrator, operation is declared practically noiseless. It is suggested for heavy-duty applications requiring continuous flow of weight bulk materials. Cleveland Vibrator Co.

26—REDUCING VALVE direct operated, for steam or air

No. 17-1 Reducing Valve designed to provide accurate control of steam pressures in a wide variety of plant applications. It features accurately sized and located ports to minimize fall off; iso-

HAGAN NEWSLETTER
Behind the Panel

THE DAY THEY MISSED THE LUNCH WHISTLE

It wasn't planned that way--it was just that this group of engineers got so interested in the PowrMag story that they ignored the lunch whistle. Small wonder--because magnetic amplifiers are claiming top attention from instrument engineers today, and the way Hagan uses them makes them even more interesting. Here is a system that is almost an exact analog of a similar pneumatic system--easy to understand, easy to work with. All the advantages of solid state--no tubes--no transistors--and circuitry that is so simple that maintenance problems become a minor consideration. Passive networks, parts of the compact plug-in box, provide proportional band, reset and rate action. All parts are high quality components, operated far below their ratings--result, high stability and long life. A unit will use no more than 2 or 3 watts, so heat is no problem. DC signals mean centralized control is possible at any distance, and outputs are compatible with data processors and computers. If you feel a lunch hour would be well spent listening to the PowrMag story, give Hagan a call. (Item K-1)

BOILER FOR SOUTH AMERICAN STEEL MILL FIRES FIVE FUELS--AUTOMATICALLY

Hagan systems, including combustion, 3-element feed water and furnace pressure controls, will be installed on a 53,000 KW station in South America. Two boilers, each producing 350,000 lb. steam/hr., at 900 psig and 900 FTT, will be fired with the following fuels, in the order given: coke breeze, blast furnace gas, coke oven gas, heavy fuel oil. Provisions have also been made to fire pulverized coal at a future date. Because of the number of fuels and the complicated firing procedure, a special set of interlocks have been incorporated into the control system. The boilers are designed to burn a preset rate of stoker-fed coke breeze, so this amount is deducted from the total fuel demand. When required, blast furnace gas is fired if pressure indicates it is available. As demand exceeds this combination, coke oven gas is fired, and so on, all automatically. This five-fuel system represents the next step in the art of multiple fuel firing, pioneered by Hagan. Operating under typical steel mill load, the combustion control system is designed to follow load swings that may range as high as 60%, with peak intervals as low as two minutes and peak durations of thirty seconds. (Item K-2)

HAGAN CONDUCTIVITY METER SAFEGUARDS CRITICAL SOLIDS CONCENTRATIONS

Where the concentration of dissolved solids in a solution is critical, the Hagan Conductivity Recorder and Sampling Cell provides a continuous reliable measurement for a moderate investment. The Hagan Model H-0 may be utilized as a single instrument, or up to four different conductivity measurements may be recorded in a single instrument case. The recorder may be mounted up to 1000 feet from the point of measurement. For the determination of dissolved solids in steam, appropriate cooling coils, steam dryers and degassers are available. For feed water and condensate systems, where fluid temperatures do not exceed 140F, the conductivity cell may be used without cooling. Temperature compensation is automatic and continuous, and limit switches may be installed to activate alarms to notify operators of a drastic change in conductivity. This protects systems where cooling water leaks into the condensate may occur. (Item K-3)

TOP PRESSURE CONTROL INCREASES BLAST FURNACE EFFICIENCY

Iron production in a blast furnace can be raised by increasing the weight of gas per cubic foot within the furnace, bringing more oxygen in contact with the burden. Hagan Automatic Top Pressure control accomplishes this without increasing gas velocity, thus avoiding raising of dust loading. A typical installation in an eastern steel mill made use of existing butterfly valves, one 30", the other 54". Since only the 30" valve had good regulating characteristics, the two valves are operated in parallel, providing adequate capacity for handling system gas as well as system bias. A blocking valve, operated by a limit switch on the charging bell, overcomes the momentary surge that would occur each time the bells were set. Such surging has the effect of tightening the burden. Since the installation of the Hagan system, iron production has increased, and furnace operation is smoother. (Item K-4)

HAGAN CHEMICALS & CONTROLS, INC.

Hagan Building, Room 709, Pittsburgh 30, Pennsylvania
In Canada: Hagan Corporation (Canada) Limited, Toronto
European Division: Via Flumendosa No. 13, Milano, Italy

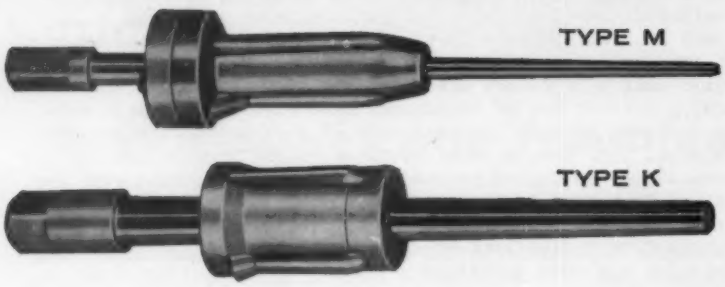
If you would like more information on any of the above items, check the appropriate box below.

☐ Item K-1 ☐ Item K-2 ☐ Item K-3 ☐ Item K-4

For more data circle 558 on Post Card

write for your copy of this Bulletin!

ELLIOTT
Boiler Tube Expanders
for tubes 3/4 in. I.D. and up



This 16-page bulletin describes general types of Elliott boiler tube expanders for fast, efficient tube rolling jobs. It also gives dimensions, prices and other descriptive data and shows various drum, header and short series mandrels which are used with Elliott boiler tube expanders. Drum mandrels are seen with Type M and Type K above.

Accessories available to adapt Elliott boiler tube expanders to various tube rolling applications include universal joints and extension shafts, sockets, gear drives, etc. A new heavy-duty, right-angle gear drive utilizes roller bearings to minimize friction, cutting down power losses.

RIGHT-ANGLE GEAR DRIVE▸
Available in ½, ¾ and 1-in. sizes

Write the Elliott Company, Lagonda Division, Springfield, Ohio, *today*, for your copy of Bulletin Y-46.

Y7-9

ELLIOTT Company
For Tube Cleaners, Expanders and Accessories

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

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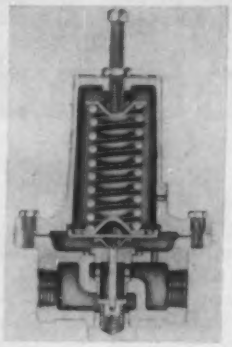
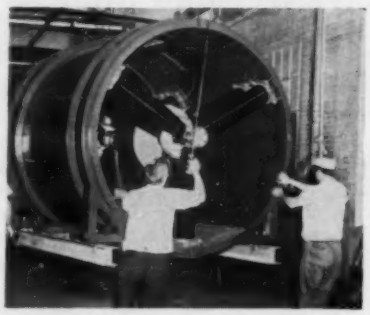
lated diaphragm chamber for maximum stability; large body passages; and lapped seating surfaces for tight shut-off.



(A variation, No. 17-22, is made with a special soft seat for air service.) Sizes of the No. 17-1 are ½, ¾ and 1 in. Reduced pressure ranges are 2 to 12, 8 to 50 and 25 to 150 psi. Mason-Neilan Div. Worthington Corp.

27—BUS-ENCLOSED SWITCH requires no extra room

Completely enclosed in a section of isolated phase bus, this space-saving high-voltage switch is designed for use with runs of isolated phase bus. With it, metal-enclosed switching stations can be built on as little as half the space required for open switchyards, says manufacturer; also, these stations can be built vertically up into previously unused space. All of the switching mechanism is contained within the bus housing and telescoping blade action



eliminates need for extra space for blade storage; no additional lengths of bus are required when the switch is added to a standard run. Also, it is pointed out, the metal-enclosed equipment limits faults to phase-to-ground types and assures that no live parts are exposed. Ratings range in voltage from 69 through 230 kv, current to 2000 amp. I-T-E Circuit Breaker Co.

28—HYDRAULIC PUMP is two stage, high pressure unit

The Vanguard is designed to deliver from 600 cu in. per minute at 100 psi to 50 cu in. per minute at 10,000 psi and weighs only 45 lb. It is pointed out that exceptional speed at low pressure in this high-pressure pump means that cylinder pistons can be adjusted to the work faster, before the high-pressure stage is needed. Overall dimensions are 10¾ by 12⅝ by 17½ in. high. The Vanguard is described as a quiet-operating, two-

New
CYCLO-TRELL
MECHANICAL
DUST COLLECTORS

These new Cyclo-trells can be built to fit any specific job. Available in Types C-10 (10″ diameter), C-24 (24″ diameter), IC (involute Cyclo-trell), ICL (involute Cyclo-trell, lined) and C-24-L (24″ lined). Also available: a new hopper discharge valve.

Write now for your copy of new Bulletin 300 which gives details and illustrations of the new Cyclo-trells and hopper discharge valve.

Research-Cottrell, Inc.

RESEARCH COTTRELL INC TRADEMARK RC 203

Main Office and Plant: Bound Brook, New Jersey

REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA

For more data circle 560 on Post Card

Quality at the Right Price... Covers All Services

Yes, when you want the *best* for the *particular job*, you can get it with "John Crane" Sheet Packings. That's because this complete line offers choice of grades, choice of materials and choice of construction to give you what you want most: *sensible economy combined with positive handling of the particular service conditions.*

Tell us about your service conditions and we'll promptly recommend what's best for you. Order *your* sheet packing from Crane Packing Co. Request Bulletin P-328 for detailed information on the complete line.

Crane Packing Co., 6429 Oakton St., Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

**DuPont Trademark*

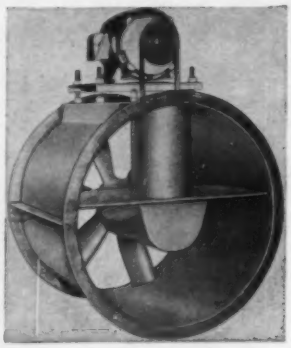
For more data circle 561 on Post Card

stage unit, driven by a universal motor, and consisting of a gear pump for the low pressure stage and a five-cylinder axial-piston pump (supercharged by the

gear pump) for the high pressure stage. Reservoir capacity is 2 gal, with 1¼ gal of usable oil. Standard universal motor is 1½ hp, 12,000 rpm, 60/50 cycle a-c d-c. Not dual voltage, motors for either 115 or 230 v are available. Owatonna Tool Co.

29—DUCT FANS, of fiberglass, resist corrosion

These all-fiberglass belt-drive duct fans, which in many applications offer resistance to corrosion equal to or exceeding that of all-stainless steel or all-Monel units, are being introduced at substantially lower cost, according to manufacturer. Propeller, duct section, drive housing and bearing cover on these fans are fiberglass; drive shaft and hardware are stainless steel. In design and performance this new line is identical to



company's standard belt-drive duct fans and offers the same features, including variable pitch drives permitting quick adjustment of fan speed, noise and air delivery. The fiberglass models come in 20-, 24-, and 28-in. diameters. Bulletin A-116 gives performance data. Hartzell Propeller Fan Co

30—GEAR MOTOR designed for heavy, continuous duty

Tremendous power in small space at surprisingly low cost is announced for the Model HD Gear Motor. It is suggested for use in pumps, conveyors and similar applications and described as smooth and quiet in operation. It can be had at any single speed from ½ to 1000 rpm with torques up to 1/20 hp and 175 in.-lb at 10 rpm. and can be base or panel mounted. It is totally enclosed with continual air flow over the motor. New England Gear Works.

Engineering supervision insures Gilsulate's superior protection of underground hot pipes

From the standpoint of installation cost, thermal efficiency and service life, there is no better method of insulating and protecting underground hot pipes against corrosion, chemical and electrical attack than the use of GILSULATE.

This superiority is the direct result of extensive product research by our own engineers. It is supported by tests in leading independent laboratories and engineering colleges, plus the experience gained from years of successful use in hundreds of installations.

You Get These Engineering Extras

Because we believe good service is as important as the physical benefits of the product itself, you receive the following engineering services without extra cost:

Design Assistance. Our distributors' mechanical engineers, all of whom have had extensive experience in heating and air conditioning, will work with you in preparing underground piping plans, checking soil conditions and arranging for supervision of the installation work.

Engineering "Spec-Check". Plans and specifications for all jobs requiring 30 tons or more of GILSULATE (as well as small jobs in unusual soil conditions) must be checked by our Engineering Dept. This cost-free service prevents trouble before the job is started.

Engineer Supervision of Installations. Every GILSULATE installation is supervised by a field service representative who stays on the job until it is finished. Our field engineers' daily job data sheets are your assurance (and ours) that the job meets specifications.

Whatever type of job you have in mind—school, housing project, plant or airport—if you want maintenance-free underground hot pipe insulation at low cost, specify GILSULATE.

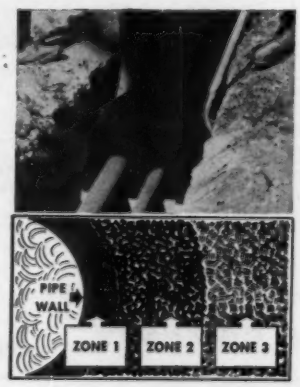
Gilsulate is easy and economical to install

1. *Needs no housing or mechanical sheaths;* no mixing, special handling or equipment. Just pour into pipe trench, shovel point it around pipes, tamp and turn on the heat.

2. *Heat fuses GILSULATE to pipes and joints* to form three zones:—Zone 1, a dense semi-plastic core to prevent corrosion, chemical and electrical attack. Zone 2, a sintered zone providing excellent thermal insulation under wet or dry conditions. Zone 3, which provides a final zone of thermal insulation and a support for Zones 1 and 2.

3. *Three Types Available:*

Type A for 220-300°F. temp. range
Type B for 300-385°F. temp. range
Type C for 385-520°F. temp. range



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TUBE MATERIALS + TUBE CONSTRUCTIONS = DIFFERENT TYPES

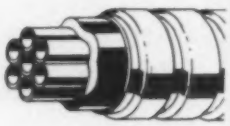
Yes, *four* different core tubing materials (copper, aluminum, polyethylene, nylon) combined with *four* distinct types of armoring give you *sixteen* different types of Dekoron Armored Instrument Harness from which to choose.

Designed specifically for instrument harness application, special Moore-Loc armor construction has almost twice the pull-apart resistance of ordinary armoring . . . has cord packing for extra resistance to moisture and fume penetration.

There's at least one best type of Dekoron for your installation. We help *you* select it; we're unbiased because we make all types. Now go Dekoron 100% for all your tubing needs. Think of Dekoron first . . . to last. That's *Dekoron—America's Premier Line of Armored Instrument Harness.* A-583A

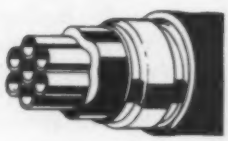
CONSTRUCTIONS

TYPE VA



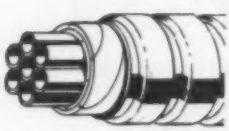
For Impact and Corrosion Resistance. Core tubes with vinyl sheath covered with Moore-Loc modified-square-lock construction armor with cord packing.

TYPE VAV



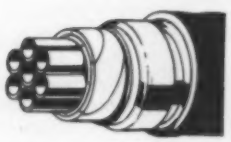
For Impact and Maximum Corrosion Resistance. Same construction as Type VA (*above*) but with outer vinyl sheath. 24-gauge galvanized steel armor gives maximum pull-apart and impact resistance.

TYPE A



For Impact Resistance in Dry Locations. Core tubes are wrapped in vinyl-impregnated insulating tape. Tape insulates and cushions core tubes inside metal armor.

TYPE AV



For Corrosion and Impact Resistance. Same construction as Type A (*above*) but with outer vinyl sheath. All four constructions available with metal or plastic core tubes.

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DEKORON PRODUCTS DIVISION • MANTUA, OHIO

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Army's Corps of Engineers

continued from page 73

laws, have assigned the responsibility for *power marketing* to the Secretary of the Interior, and four marketing agencies have been established within this department to handle these sales. Corps of Engineers has no direct responsibility in this phase of Federal Power activities.

General Statistics

Operation statistics, based on the over-all civil works program of the Corps of Engineers, amply demonstrate how the nation is benefiting from this water resource-development program. For the $3,800,000,000 that has been spent on flood control (a part of which has been invested in multiple-purpose projects with power), $9,000,000,000 in damages have been prevented. The difference between benefits received and costs incurred will, of course, continue to increase as time goes on.

Traffic on waterways improved by the Corps of Engineers has increased from 8 billion ton-miles in 1929, to 115 billion ton-miles in 1957. In 1958, releases of water for irrigation totalled 1,600,000 acre-feet, and more than 1,200,000 acre-feet are under contract for water supply. As a collateral benefit from recreation, attendance at Corps of Engineers' projects totalled 95,000,000 visitor-days in 1958.

The true total benefit from power cannot be fully measured, but it is very considerable. For those projects already in operation, the power benefits that can reasonably be evaluated exceed the costs of producing the power by more than $70,000,000 a year. This does not include the more intangible values of these projects in conserving our diminishing resources of coal and other fuels, or in stimulating industrial growth.

Also, since many worthwhile projects for flood control, navigation, and other purposes could not be built at all, unless teamed with the development of power, benefits from these other purposes are partly attributable to power.

It should be borne in mind that the investment made by the Government (in power) is, by law, to be fully repaid through revenues from the sale of power. Over a period of not more than 50 years every dollar which the Federal Government has spent to obtain these benefits will be returned to the Treasury. THE END

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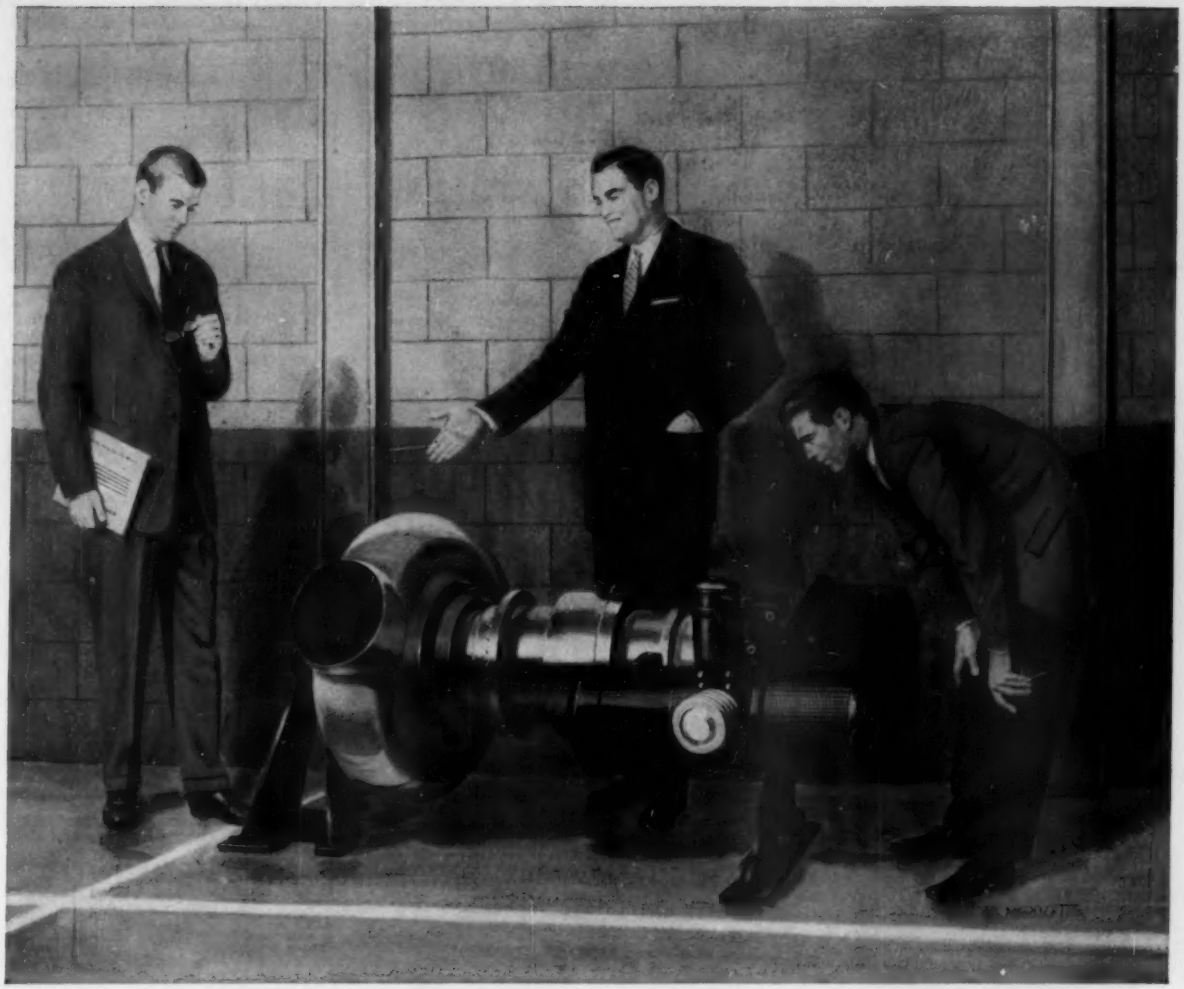
No need to tear up your copy of POWER ENGINEERING. We'll be glad to furnish you extra pages of articles. Just write the Editor on your letterhead or use the enclosed post card, and jot down the title that interested you.



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New Solar gas turbine offers small size, light weight, greater fuel efficiency

SOLAR'S REMARKABLE NEW 1100 hp *Saturn* gas turbine represents an important forward step in gas turbine fuel efficiency—requiring only .63 pounds of fuel per hp hour. The engine is extremely lightweight, averaging less than 1/10th the weight of conventional engines of similar hp; it occupies only about 51 cubic feet; it starts instantly and takes full load without laboring in temperatures from −65F to 130F, even after long periods of standby service. And the new Solar *Saturn* engine will operate on a wide variety of fuels.

Today, proven-in-service Solar gas turbines—ranging from 50 to 1100 hp—are creating new standards of performance and reliability. As propulsion units for boats, as a dependable power source for electric generators, as high-efficiency pumps and in other applications... Solar gas turbines are saving time and money for hundreds of satisfied users. For a new gas turbine brochure, write to Dept. G-138, Solar Aircraft Company, San Diego 12, Calif.

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NEW ENGINEERING BOOKS

continued from page 44

Automation and Society, edited by Howard Boone Jacobson and Joseph S. Roucek, 533 pages, 6 by 9 in., buckram binding. Published by Philosophical Library, 15 E. 40th St, N.Y. Price $10.

This excellent work consists of 32 individual essays on virtually all aspects of automation and its relationships with society and the progress of society. These are divided into three sections, The Concept of Automation, Automation Applied, and Automation and Responsibility. Two appendices contain an extensive automation dictionary and 37 short case histories of automation in the U. S. and Canada.

That the field of power engineering is deeply rooted in the development of automation is evident in the first essay, which describes the rise of the concept of automation. Indeed, most of the early developments in what we now call automation were in the power field, concerned with such things as governing the speeds of steam engines by feedback from a flyball governor (James Watt, 1788), and the use of feedback in the control of the steam steering engine of the *Great Eastern* in the 19th century.

It is disappointing, therefore, that after these initial references, little or no mention is made of the fact that the power engineers have continually stayed in the forefront of the science of automating, that they are now among the leaders in the field, and that the operation of power plants by computers is now an accomplished fact. Indeed, though numerous chapters are dedicated to the progress and present state of the art in virtually every other industry, plus commercial and educational institutions, the decades in which the power engineering profession has led the field are essentially ignored.

There is a vast amount of information of great value in the book, however, and it is an important addition to the literature which considers the impact of automation upon the social order.

★ ★ ★

Power Unlimited! and **Tomorrow the Moon!** by Abraham and Rebecca B. Marcus, 150 and 152 pages, 5½ by 8¾ in., cloth bound. Published by Prentice-Hall, Inc, 70 Fifth Ave, New York 11, N. Y. Price of each volume, $3.50.

Abraham and Rebecca Marcus, a husband and wife team, have been science teachers in New York City public schools for more than 20 years. In these two books they present the world of modern science and its applications in simple, everyday language. Plenty of explanatory drawings and photographs support the text.

Power Unlimited! is the story of power from the windmill to nuclear energy. Its

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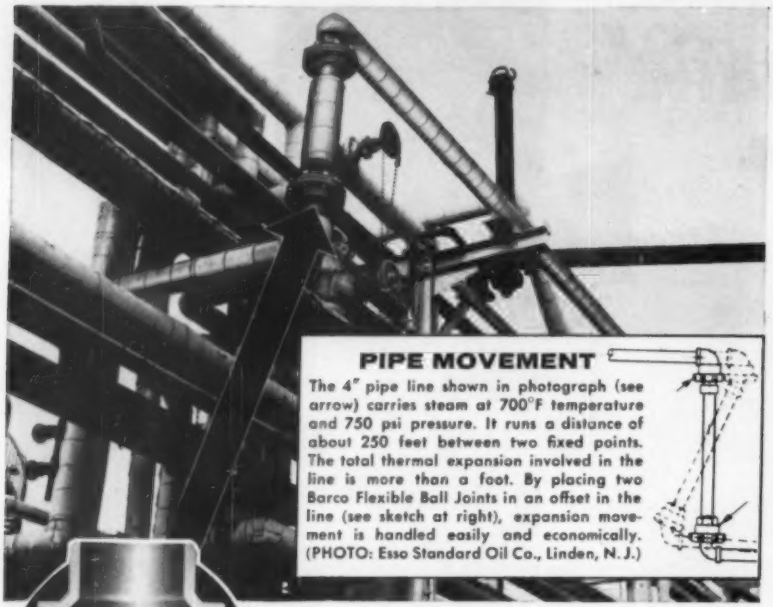
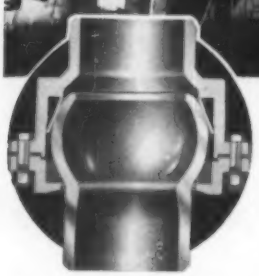
How Plant Handles 700°F. STEAM . . . PIPE EXPANSION



PIPE MOVEMENT

The 4" pipe line shown in photograph (see arrow) carries steam at 700°F temperature and 750 psi pressure. It runs a distance of about 250 feet between two fixed points. The total thermal expansion involved in the line is more than a foot. By placing two Barco Flexible Ball Joints in an offset in the line (see sketch at right), expansion movement is handled easily and economically. (PHOTO: Esso Standard Oil Co., Linden, N. J.)



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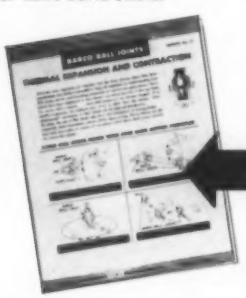

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sixth chapter, on putting electricity to work, takes up the d-c motor, a-c motor, polyphase motors and single-phase motors.

A companion volume in style and objective, Tomorrow the Moon! concentrates on the evolution of space technology. The principles of rocketry are clearly explained, and such questions answered as: How close are we to reaching the moon?; What will the moon be like?; What are the differences between IRBM and ICBM?; How will space stations provide stepping stones to outer space? Diagrams and photographs are as lively as the text.

★ ★ ★

ASTM Standards — 1958, Part 1 — Ferrous Metals, 1594 pages, 6 by 9 in., cloth binding. Published by American Society for Testing Materials, 1916 Race St, Philadelphia 3, Pa. Price $12.

ASTM has started publishing the 1958 Book of Standards, and Part 1 has gone out for distribution.

The complete set will consist of ten parts, with 13,600 pages and 2450 standards. Total cost of the complete set is $116.

Subjects of the set are: 1. Ferrous Metals; 2. Non-Ferrous Metals, Electronic Materials; 3. Methods of Test for Metals; 4. Cement, Concrete, Mortars, Road Materials, Waterproofing, Soils; 5. Masonry Products, Ceramics, Thermal Insulation, Sandwich and Building Constructions, Acoustical Materials, Fire Tests; 6. Wood, Paper, Adhesives, Shipping containers, Cellulose, Leather; 7. Petroleum Products, Lubricants, Tank Measurements, Engine Tests; 8. Paint, Naval Stores, Aromatic Hydrocarbons, Coal, Coke, Gaseous Fuels, Engine Antifreezes; 9. Plastics, Electrical Insulation, Rubber, Carbon Black; 10. Textiles, Soap, Water, Atmospheric Analysis, Wax Polishes.

This is the ASTM's largest Standards; the various parts will come off the presses as rapidly as possible.

★ ★ ★

Handbook of Air Conditioning, Heating and Ventilating, 1094 pages, 8 by 10¾ in., cloth binding. Published by The Industrial Press, 93 Worth St, New York, N. Y., 1959. Price $15.

Here, in one volume, is collected practically all the information needed by designers and contractors to solve their daily problems.

It has been compiled by the editors of *Air Conditioning, Heating and Ventilating* magazine, from many authoritative sources. An extremely fine job has been done in presenting all data in condensed and easy-to-use form.

Handbook is divided into eight sections: Air conditioning, Air handling and ventilation, Fuels and combustion, Heating and heat transfer, Piping and plumbing, Motors and starters, Mathematical data and drafting symbols, and Terminology.

Book includes tables of heat loss from insulated pipe, for nine different K values — and all pipe sizes. Also, new information on heat loss through various types of win-

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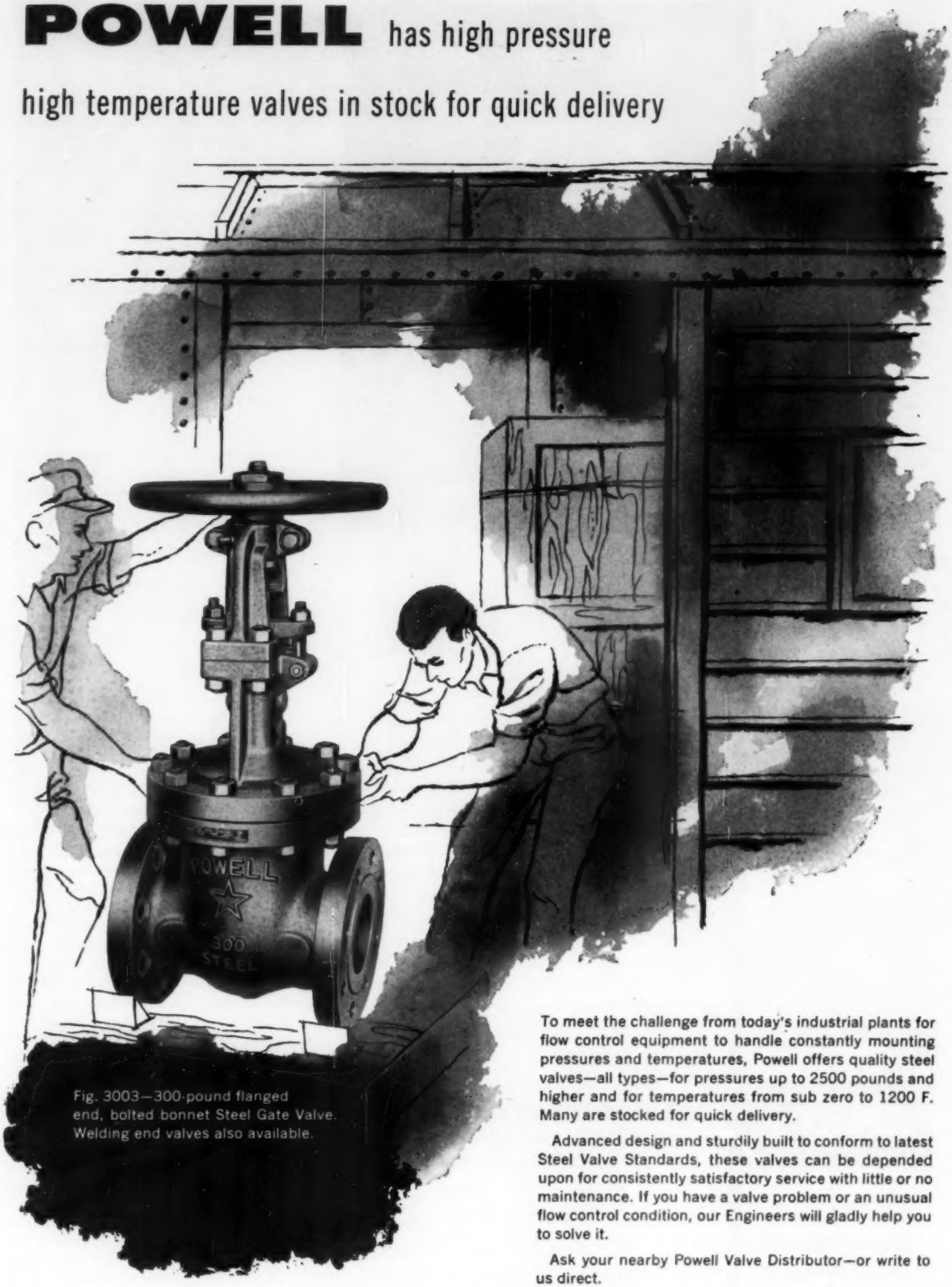

Fig. 3003—300-pound flanged end, bolted bonnet Steel Gate Valve. Welding end valves also available.

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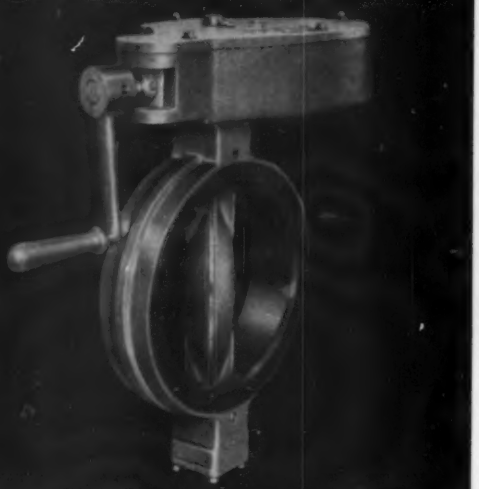
the MONOFLANGE MARK II



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dows, climatic maps, and steam flow in pipes.

There are 598 charts, maps and illustrations; also 518 tables.

★ ★ ★

Engineering Manual, prepared by a staff of specialists under direction of Robert H. Perry, Editor-in-Chief; 356 pages, 5 by 8 in. Published by McGraw-Hill Book Co, 327 W. 41st St, New York 36, N. Y. Price $9.50.

An extremely useful supplement to any professional library, the manual brings together in one volume the most commonly used data and methods in the architectural, chemical, civil, electrical, mechanical, and nuclear engineering fields. Everything, from basic principles and fundamentals in each of the engineering fields — right down to their applications, is instantly available for quick, easy reference.

Mathematics, mathematical tables, and physical and chemical data common to the major engineering sciences are brought together in three separate sections prefacing the manual. Specialized tables, graphs, formulas, and hundreds of other aids are presented within the appropriate engineering sections.

★ ★ ★

The Modern Slide Rule, by Stefan Rudolf; 70 pages, 8¼ by 11 in., paper cover. Published by The William-Frederick Press, 391 East 149th St, New York 55, N. Y. Price $5.

This book presents a new method for the use of the slide rule in fundamental mathematical operations. The method permits the exact fixing of the decimal point in the result as it appears on the scale of the slide rule — without approximate calculations. The many calculations presented here illustrate the procedure. Selected drill problems, with answers, are included to help the student develop speed and accuracy.

★ ★ ★

Structural Design for Dynamic Loads, by Norris, Hansen, Holley, Biggs, Namyet, and Minami; 453 pages, 6 by 9 in., 20 chapters. Published by McGraw-Hill Book Co, 327 W 41st St, New York 36, N. Y. Price $12.50.

In the summer of 1956, a special two-week program on structural design of dynamic loads was offered at Massachusetts Institute of Technology for engineers particularly interested in blast-resistant and earthquake-resistant construction. This book is an amplification and refinement of the lecture notes used in that program.

It is not a text or reference book covering the subject. Rather, it is intended as a survey of the field of structural design for dynamic loading and as a guide to the engineer who is studying in this area. The twenty chapters of the book have been divided into four main sections: Part 1. Behavior of Materials Under Dynamic Loading; Part 2. Calculations of Response of Structural Systems to Dynamic Loading; 3. Modern Computational Techniques Applicable to Response Calculations; 4. Application of Structural Design and Analysis to Specific Cases Involving Dynamic Loading.

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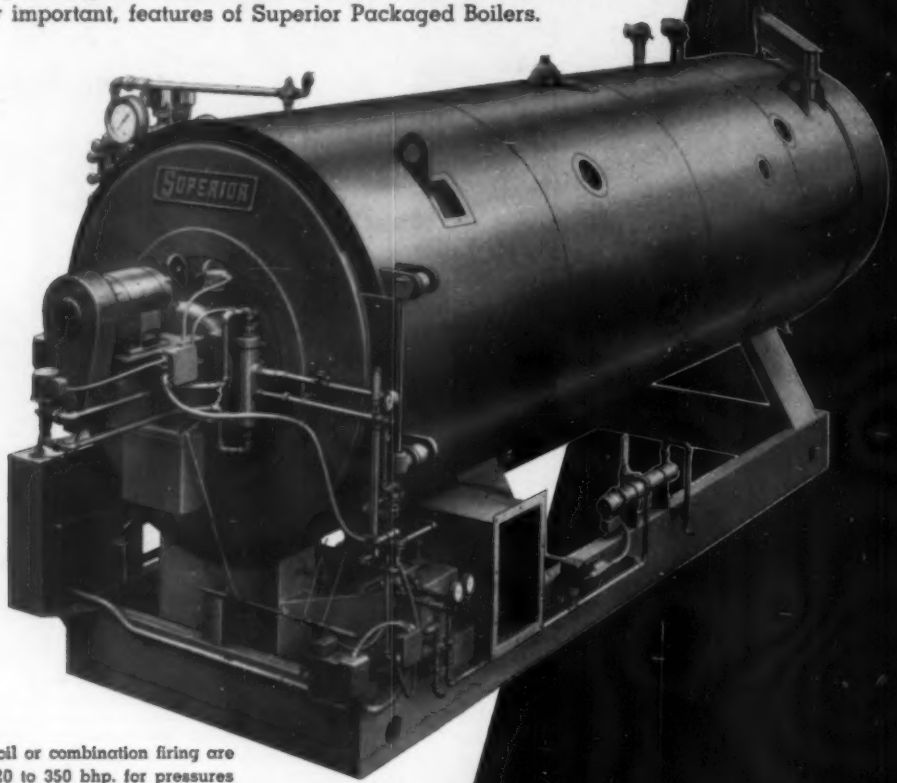

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BOILERS, GENERATORS

201 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features. Gives dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

202 Hot Water Boilers — This 20-pp Brochure HCC-2 describes and illustrates design, construction, advantages and economics of the C-E La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process uses. Combustion Engineering, Inc.

203 Boilers for Many Services — This general product data catalog in loose leaf notebook form contains detailed literature on company's line of boilers for heating, power and process steam. It contains separate data sheets for each product, including high pressure boilers, low pressure boilers, boiler-burner units, water-tube boilers, water heating equipment and others. In addition to photos and diagrams it provides tabulated engineering data. Industrial Div., American-Standard.

204 Packaged Steam Generator — Advantages of company's baffleless, pressurized two-drum water tube packaged units are detailed in 12-pp Catalog SB-59. Features of the completely integrated generating plant, which requires no field piping, wiring, brickwork or special foundation, are shown on cutaway illustration. Erie City Iron Works.

206 Integral-Furnace Unit — Bulletin G-94 describes the Type PFI integral-furnace boiler, a pressurized-furnace oil- and gas-fired steam generator for power, process or heating loads requiring steam capacities to 400,000 lb-hr at pressures to 1150 psi and temperatures to 900 F. Includes information on membrane wall. The Babcock & Wilcox Co.

207 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are finished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

REFRACTORIES

208 Refractory Castable — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the mainte-

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nance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

209 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing; also information on use of Lumnite cement as a masonry mortar for laying brick. Universal Atlas Cement Div., United States Steel Corp.

TUBING AND ACCESSORIES

210 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers. Field of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

211 Instrument Tubing — Detailed information on various types of instrument tubing and accessories is presented in this 16-pp bulletin. Among tubing described is extruded polyethylene tubing, extruded nylon tubing, tubes of copper, aluminum, and/or steel with polyethylene sheath, tubing with vinyl sheath, bundled instrument tubing. Dekoron Products Div., Samuel Moore & Co.

212 Aluminum Tube — This 32-pp catalog contains detailed information on company's drawn aluminum tube and extruded aluminum tube and shapes. Describes special features of the metal, metallurgical aspects, mechanical, physical and chemical characteristics, tolerance standards and extrusion definitions. Wolverine Tube, Div. Calumet & Hecla, Inc.

214 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in others. Revere Copper and Brass, Inc.

FANS

216 Mechanical Draft Fans — Bulletin FD-905, 28 pp, describes a mechanical draft and other heavy-duty fans for a variety of industrial applications. Includes basic data for proper fan selection, performance tables, design sketches, component and installation photos of many types from kiln fans to cyclone compressors. Buffalo Forge Co.

218 Air Engineering — Bulletin E-57 is a 24-pp air engineering data file covering engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses are provided. Aerovent Fan Co., Inc.

FUEL BURNING EQUIPMENT

220 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic

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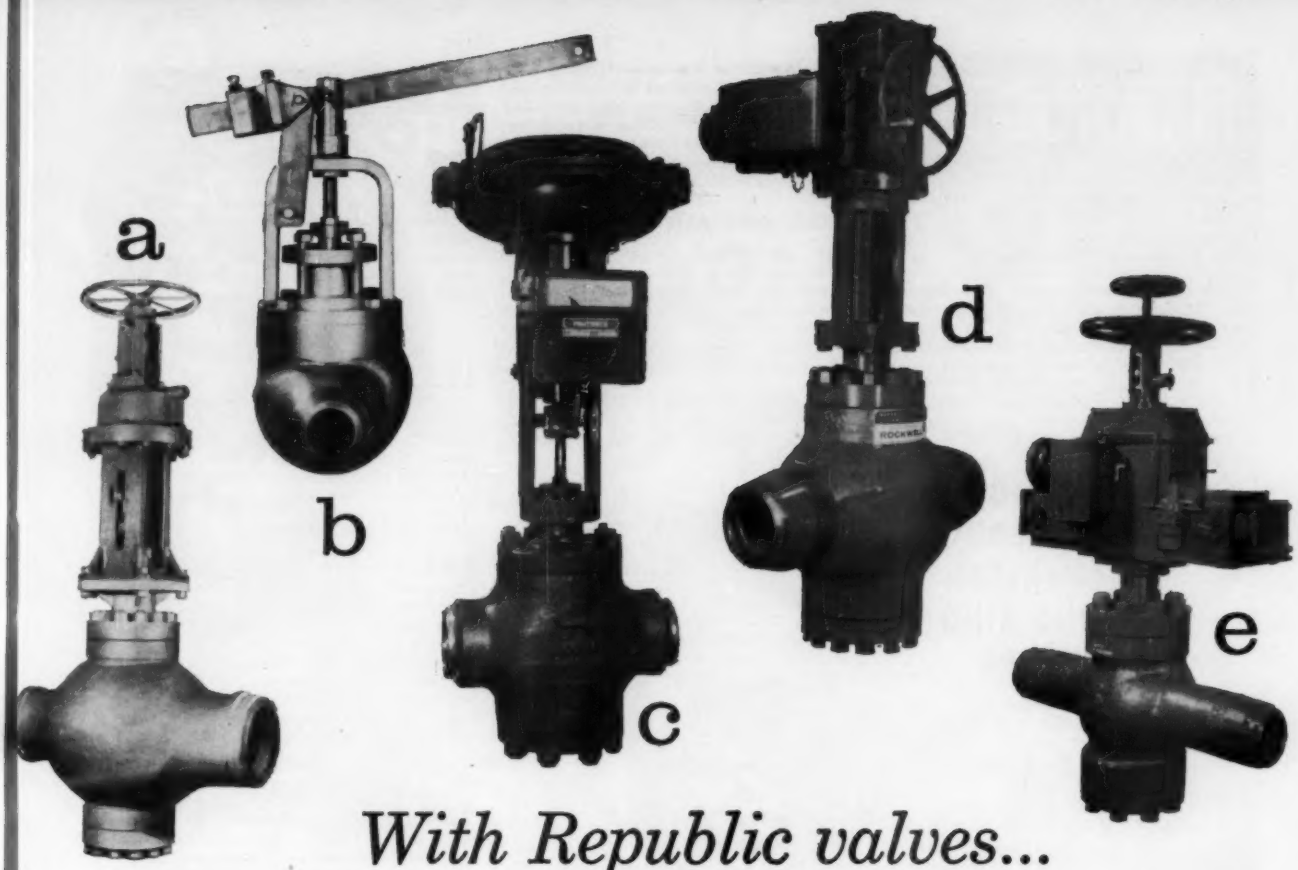

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And, for many special applications, such Republic accessories as pneumatic and electric valve positioners for hysteresis-free control, and a complete line of controllers are available.

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refuse fuel distributor which spreads refuse fuel such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses various components. Riley Stoker Corp.

222 Firing Units — Bulletin 28 describes steam atomizing packaged firing units for oil and/or gas fuels. Gives advantages of the units, specifications and general dimensions, and other data. National Airoil Burner Co., Inc.

223 For Low-Pressure Heating — Guide Specifications GS-1, 59 pp, covers underfeed stoker applications to boilers best suited to commercial and industrial heating plants. Includes drawings of flexible layouts of the equipment, as well as specification criteria covering coal and ash handling, boilers, stokers and controls. Bituminous Coal Institute.

225 Spreader Stoker — Catalog 860 contains 20 pp of detailed information on company's overthrow rotor type spreader stoker for boilers of medium size up to 60,000 lb steam per hr capacity. Describes features of design and operation and illustrates applications. Detroit Stoker Co.

COAL AND ASH HANDLING

226 Shredders, Crushers — Bulletin 257 describes and illustrates hammermills and shredders, rolling ring and special crushers for reducing chemicals, minerals, ceramics, and other materials including wood waste. Discusses construction features. American Pulverizer Co.

228 Coal Sample Crusher — How you can save on your fuel bill and power cost with company's coal sample crusher is explained in Bulletin CS2. Illustrated with photos and dimensional diagrams, discusses operation and features. Gruendler Crusher & Pulverizer Co.

229 Car Dumper — Sixteen-pp illustrated Brochure 957 describes a rotary car dumper capable of handling hopper and gondola cars and equipped with clamps which hold the dumper car without counterweights. These and other design features are explained and installations pictured. Heyl & Patterson, Inc.

PUMPS, COMPRESSORS

230 Flow Control — Twelve-pp Catalog 801 describes four basic models of precision proportioning pumps for uses requiring accurate and positive proportioning of flow in range of 0 to 730 gph. Materials of construction, capacities and pressures are shown for each. Diaphragm valves are discussed and their features noted. Hills-McCanna Co.

232 Air Compressors — Performance advantages of company's heavy duty V-vertical air compressor featuring aluminum maintenance and compactness are detailed in 24-pp Bulletin Ref. 1230. The V-vertical construction details are shown on cutaway and components described, as well as force feed lubrication and mounting types. Specifications and dimensions are included. Joy Mfg. Co.

TURBINES

234 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

235 Turbine Lubrication — Basic lubrication requirements for a wide range of turbines and gears are detailed in 28-pp Bulletin T-125-A. Sections cover care of the oiling system, turbine lubricants, lubricating oil recommendations, reduction gears and geared units. Oil circuit diagrams and other illustrations are included. Murray Iron Works Co.

236 Gas Turbine Engines — A variety of applications for company's gas turbine engines are described in this 8-pp bulletin. Among the applications described are ground support for commercial jets, emergency shipboard use, offshore oil industry, others. Solar Aircraft Co.

PACKINGS, GASKETS

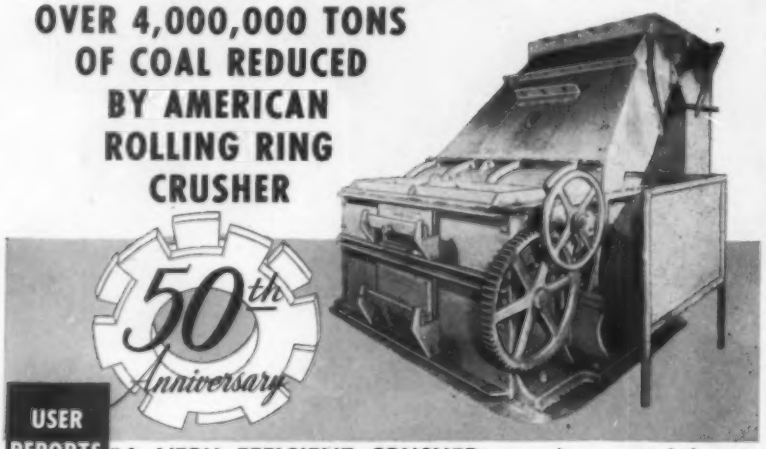
239 Mechanical Packings — Catalog P-210C contains 40 pp of detailed information on company's line of mechanical packings and gasket materials. It contains illustrations, descriptions, complete service recommendations and specification charts. Raybestos-Manhattan, Inc.

240 Sheet Packings — Eight-pp illustrated Bulletin P-328 gives detailed specifications, engineering, application and testing data on industrial sheet packings. Nineteen varieties covered are fabricated from asbestos, rubber, Neoprene, silicone, fiber, Teflon, others. Crane Packing Co.

WATER CONDITIONING

242 Boiler Water Treatment — Chemical reduction of oxygen in boiler

OVER 4,000,000 TONS OF COAL REDUCED BY AMERICAN ROLLING RING CRUSHER



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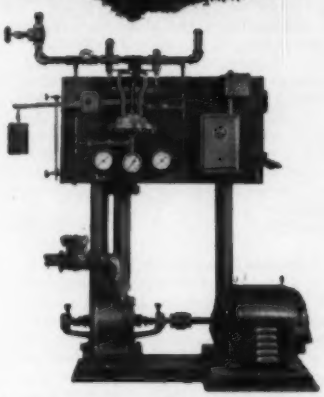
Cut Steam Costs

with Stickle's differential drainage and boiler return system



A closed pumping system for returning condensation from heating and processing equipment under pressure directly to boiler at temperatures only 15 to 20 degrees lower than those at operating pressure. For plants using steam pressures between 50 and 250 lbs. Cuts the cost of steam these eight ways:

1. Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.
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3. Reduces use of raw make-up water 85% to 90%.
4. Cuts maintenance on boilers, steam lines, traps and valves.
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Cuts the cost of steam

Steam Traps • Feed Water Heaters
Regulating and Reducing Valves
Drainage and Boiler Return Systems

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feedwater with hydrazine is the subject of 10-pp Bulletin BW. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

243 Consulting Service — Advantages of company's consulting service are detailed in 8-pp Bulletin 5006-A. How the service is qualified to solve problems concerning scale and corrosion control in boilers, cooling systems, and process waters is discussed. Dearborn Chemical Co.

245 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. Stickle Steam Specialties Co.

INSTRUMENTS, CONTROLS

247 Controls Data — Comprehensive data on all types of controls, including diaphragm valves, pilot controllers, regulators, safety heads and tank vents are presented in this loose leaf notebook. Individual sections contain all pertinent information on each specific product, including descriptive details and engineering data, dimensions, specifications. Application and operation details are fully illustrated. Black, Sivalls & Bryson, Inc.

249 Testing Instruments — Bulletin 19–58, 16 pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos of each type. James G. Biddle Co.

252 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft, Dura-gauges, Maxisafe, pneumatic receiver, recording, quality, drawn case, chemical and special application gages. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in. Manning, Maxwell & Moore, Inc.

254 Automatic Data Systems — Described in Bulletin MSP-154 are electronic data handling systems for logging, monitoring, and integration of process information. Discusses basic design parameters, programming, switching, analog to digital conversion, linearization, calibration, digital ranging, print-out and off-normal alarms, remote switching, digital variable indication, integration, computation. Hagan Chemicals & Controls, Inc.

257 Instruments and Controls — Catalog 57–6 describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorders, temperature recorder, multipoint gages and others. Includes descriptive data. Republic Flow Meters Co.

258 Resistance Temperature Detectors — In 8-pp Publication 3016D is described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring

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equipment. Operations, application and construction details of the resistance temperature detectors are presented. Instrument Div., Thomas A. Edison, Inc.

259 Industrial pH Equipment — Eight-pp Bulletin 5400 gives detailed description and specifications for industrial pH instruments, electrodes and accessories manufactured by the company. Brochure is profusely illustrated with photos and detailed drawings. Process Instruments Div., Beckman Instruments, Inc.

261 Oil Leak Detection — Eight-pp illustrated Bulletin 80, on the Paraprobe oil leak detection system for steam-type fuel oil heaters gives a detailed explanation of the operation of the system. Provides installation diagrams, standard specifications, explains determination of condensate flow rate. Davis Engineering Corp.

INSULATION

264 Insulating Block — An insulation block fabricated from high temperature resisting minerals and effective up to 1700 F is described in 8-pp Bulletin 518-J. Provides thermal conductivity graph, size and thickness data, describes insulating-finishing cement. Baldwin-Ehret-Hill Co.

265 For Insulation Protection — Comprehensive data on mastics, coatings, adhesives, and flashing compounds for thermal insulation has been classified as to industry usage — power, process, cold storage, marine and commercial — in this ready-reference loose-leaf manual, about 208 pp. Detailed application information and product data is included, as well as photos, drawings and diagrams of applications. Benjamin Foster Co.

MECHANICAL POWER TRANSMISSION

270 Power Transmission Equipment — Bulletin 7900-BIP, 12 pp, is designed as a general catalog on mechanical power transmission equipment. Contains selection charts for heavy duty QD sheaves, light weight and QD Junior sheaves, V-belts, and variable speed drives, including all-speed drives, motor drives, and pulleys. Worthington Corp.

273 Grommet V-Belts — Advantages of company's grommet V-belts are illustrated and described in this 8-pp bulletin. Belt features are fully described, and a section on how to figure a V-belt drive is included. Goodall Rubber Co.

VALVES, TRAPS, AND PIPING

275 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations, describing non-return (stop check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Edward Valves, Inc.

278 Forged Steel Valves — Featured in comprehensive Catalog F-10 is detailed information and engineering data on company's line of forged steel valves, fittings, flanges and unions. Includes photos and cutaway views illustrating component features, as well as tables giving dimensional data. An engineering design section with complete specifications and pressure-temperature tables is included. Henry Vogt Machine Co.

279 Reducing Valves — Bulletin 5302-B contains 20 pp of detailed information on selecting, specifying and ordering reducing valves and pressure regulators. Includes cutaway views showing features, as well as quick reference tables, pressure ranges and construction. Leslie Co.

280 Synchronous Motors — Advantages of company's high speed synchronous motors are detailed in 12-pp Bulletin 501. Cutaway view illustrates component parts and details of maintenance and operation. Applications and specifications data included. The Ideal Electric & Mfg. Co.

281 Safety, Relief Valves — Catalog 900-V contains 58 pp of comprehensive data on safety and relief valves for boilers, air receivers, hydraulic systems process equipment, and general pressure vessel protection. Includes glossary of terms, valve selector tables, selected technical data and condensed specifications. Cutaway views showing component parts are also included, as well as curves showing overpressure correction factors. J. E. Lonergan Co.

283 Steam Trap Book — Catalog K, 48 pp, is a manual of steam trapping practice. It includes a section giving physical data and prices on OF&T traps, cast semi-steel and forged steel inverted bucket steam traps, compound traps, ball float air and air relief traps. A handbook section explains how to calculate condensate load, and select traps for all classes of equipment; a maintenance section explains trap instal-

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lation, testing, and maintenance. Armstrong Machine Works.

284 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. The Henry Pratt Co.

285 Steam Trap — Bulletin 257-B describes a steam trap which uses the kinetic energy of steam to close the valve. Features of trap are detailed, and dimensional data included. Sarco Co., Inc.

287 Insulated Piping — Described in 20-pp Catalog 59-1 are prefabricated insulated piping systems for underground and overhead use. Cutaway views showing design and construction features are included, as well as dimensional diagrams and data, and photos of typical applications. Ric-wil, Inc.

OTHER EQUIPMENT

290 Sheet and Plate Fabrication — Illustrated in 40-pp Bulletin F-3 are products of this manufacturer, and equipment used to produce special sheet steel and alloy parts. Shows control panels, switch gear housings, cubicles and other electrical enclosures, boiler air ducts, smoke breechings, tanks. The Kirk & Blum Mfg. Co.

292 Precipitation Products — Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates installations. Western Precipitation Corp.

293 Cooling Towers — Performance details on company's cross-flow cooling towers are presented in this 20-pp illustrated Booklet CF-59. Discusses and illustrates through diagrams the cross-flow principle of water cooling, and includes descriptions of equipment, engineering and design features. The Marley Co.

296 Brine-Making Manual — Details on modern brine-making methods and equipment are presented in 12-pp Manual 135. Three types of brine-makers are described, as well as a wet salt storage system, and cutaway views and diagrams are included. Morton Salt Co.

297 Heat Exchanger — Featured in this 12-pp bulletin is the Fin-Pak, a compact heat exchanger designed for a wide variety of fuel burning and process equipment. Structural details and operating principles are illustrated and typical installations shown. The Air Preheater Corp.

299 On Model Studies — Advantages of model studies for precipitators and other gas handling systems are presented in this 18-pp brochure. Discusses three plans under which this new engineering service is available. Several case histories are detailed to show benefits obtained. Also provided are articles on the subject reprinted from POWER ENGINEERING and other publications. Research-Cottrell, Inc

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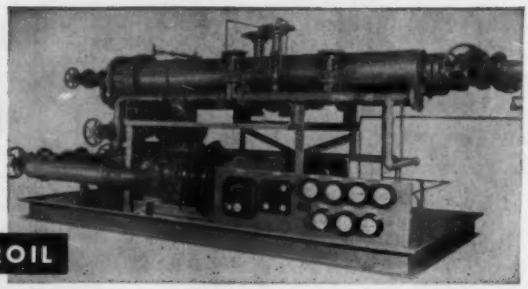

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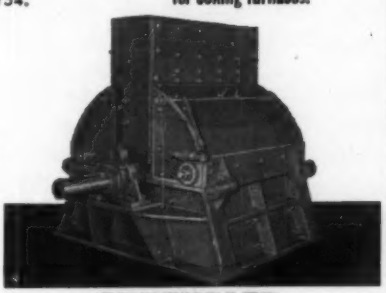

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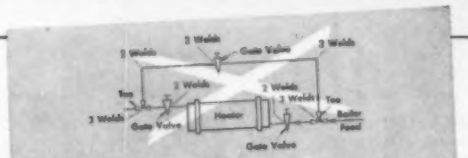

OLD BYPASS ARRANGEMENT

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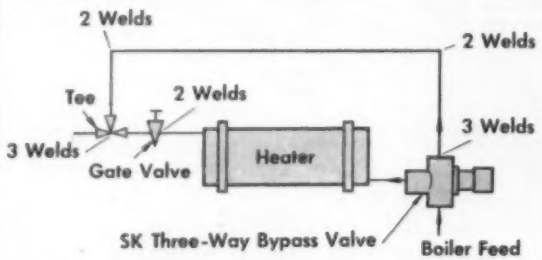
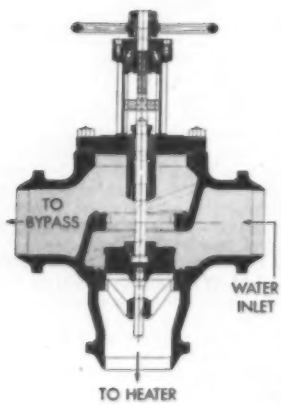


NEW BYPASS ARRANGEMENT

Makes previous arrangement obsolete . . . uses only one SK Three-Way Bypass Valve . . . requires only one tee fitting, only twelve welded connections.



The new feedwater heater bypass arrangement shown saves one two-way valve, one tee fitting, four welded connections and *cuts costs accordingly*.

Heart of the new system is the SK Three-Way Bypass Valve illustrated. This valve is designed for two-position operation. With the disc closed against the lower seat, flow passes through the bypass line. With the disc closed against the upper seat, flow is to the heater. The valve can be equipped with gearing or motor operator. Considering the savings possible, you should write for details.

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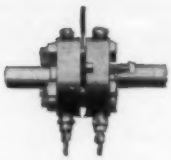

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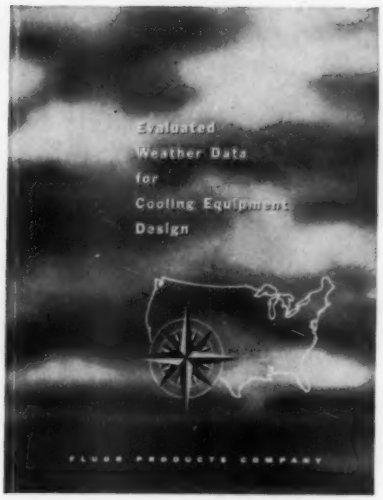

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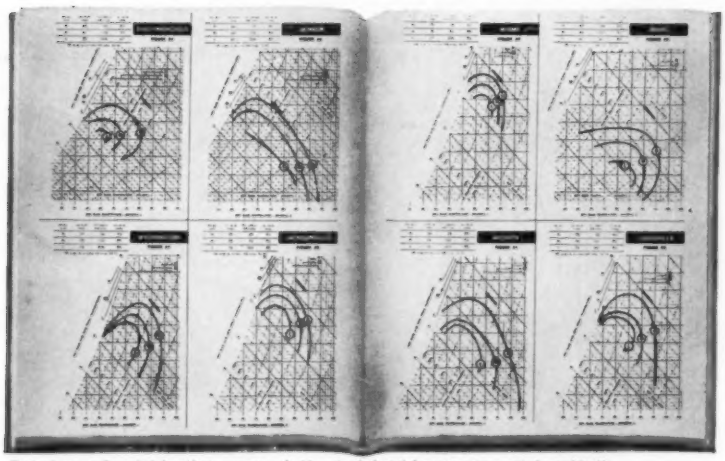

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